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CLAYS AND CLAY INDUSTRIES

OF

PENNSYLVANIA.

I. CLAYS OF WESTERN PENNSYLVANIA (IN PART).

DESCRIPTION OF THE CLAYS AND CLAY INDUSTRIES IN THE OHIO, MONONGAHELA, YOUGHIOGHENY AND CONEMAUGH RIVER VALLEYS IN PENNSYLVANIA AND THE ALLEGHENY VALLEY AS FAR UP AS KITTANNING, INCLUDING ALLEGHENY, WESTMORELAND AND FAYETTE COUNTIES AND PARTS OF BEAVER, WASHINGTON, GREENE, INDIANA, ARMSTRONG AND CAMBRIA COUNTIES.

BY

THOMAS C. HOPKINS,

Assistant Professor of Economic Geology in The Pennsylvania State College.

APPENDIX TO THE ANNUAL REPORT OF THE PENNSYLVANIA STATE
COLLEGE, FOR 1897.

WM. STANLEY RAY,

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State College, Pa.,

April 25, 1898.

Sir: I have the honor to submit herein my report on the clays and clay industries of part of western Pennsylvania, prepared according to your instructions. The field work was done during the summer vacation of 1897 and the office work at intervals during the college session now in progress. There is also included the report on the clays of Allegheny county, prepared under my directions by Mr. W. L. Affelder, a member of the Junior class in the college.

Permit me to thank you for your kind advice and encouragement in all phases of the work.

Respectfully submitted,

T. C. HOPKINS.

To the President of The Pennsylvania State College.



PREFACE.

The following report on the clays and clay industries of western Pennsylvania is the second one of the economic reports on the natural resources of the State, published by The Pennsylvania State College. The first one, published in 1897, was on the Brownstones of Pennsylvania.

The present report covers only one season's work and only a limited area of the State; but it is thought best to give the results of each year's work as promptly as possible in order to increase their value to the region under discussion. After the other sections of the State have been explored in a somewhat similar manner, we hope to embrace all the results of more or less general interest in monographs or final reports treating of both the practical and the scientific problems involved.

The present report contains such data as are thought to be of value to the trade and to the reading public, on the clay industry of one of the greatest manufacturing districts of the world.

It will no doubt be a surprise to many persons to see the extent to which the clay industries have been developed in western Pennsylvania. We are all familiar with the great commercial development of the coal, oil, iron and glass industries of the Pittsburgh region, but frequently overlook some of the less important but still quite extensive industries. The investigation shows that a capital of nearly seven million dollars is invested in the varied clay industries about Pittsburgh, of which more than three million dollars is in the fire-clay industry. The value of the annual output of material is nearly four million dollars, more than 50 per cent. of the capital invested. There are 139 companies, employing 4,403 men.

The commercial advantages accruing to the State from this home industry as an aid to the other manufacturing industries is much greater than would appear at first glance. Great as it is, however, it might with profit be developed still more extensively (1) by using more of the fire-clay parting in the Pittsburgh coal seam which now forms numerous large heaps of waste throughout the region; (2) by manufacturing larger quantities of high grade building brick, such as buff, pressed, vitrified and variegated brick; (3) by the manufacture of enamelled or porcelain brick; (4) by increasing the production of paving brick.

That some portions of the region are described with greater fullness of detail is partly due to their greater commercial importance as centres of the industry, partly because they are typical and the description applicable to surrounding localities, and partly due to the fact that some manufacturers more freely gave information in regard to their works, and facilitated in every way explorations of their mines and factories.

While it would not be possible to enumerate all the parties to whom we are indebted for courtesies and assistance rendered, some who bestowed special favors should be named. Hon. J. B. Hammond, of Bolivar, not only kindly accompanied me to all parts of the large property owned by Reese, Hammond & Co., but to all the neighboring mines, and prepared at his own expense the excellent illustrations of the mines and works at Bolivar, besides giving valuable information concerning the industry in other portions of the State. Mr. L. O. Livingstone, of New Brighton, kindly accompanied me to all the mines and works in Beaver valley. To Mr. R. R. Hice, of Beaver, I am indebted for information concerning the local geology and distribution of clays in Beaver county. Mr. A. F. Smith, of New Brighton, and the Hon. George McNees, of Kittanning, gave valuable information concerning local interests. The Wick China Co. furnished the excellent views illustrating the processes in china making.

The Clay Worker, of Indianapolis, kindly loaned numerous electrotypes of the brick works and clay mines at Pittsburgh. The Chambers' Bros. Co. of Philadelphia; the Henry Martin Brick Mfg. Co., of Lancaster, Pa.; E. M. Freese & Co., of Gallion, Ohio; the Bonnot Co., Canton, Ohio; the American Clay Working Co., Bucyrus, Ohio, kindly loaned electrotypes of machinery used in illustration.

It is to be regretted that time did not permit the examination of the upper part of the Allegheny valley area and thus render complete the river valley areas of the western part of Pennsylvania.

T. C. H.

State College, Pa.

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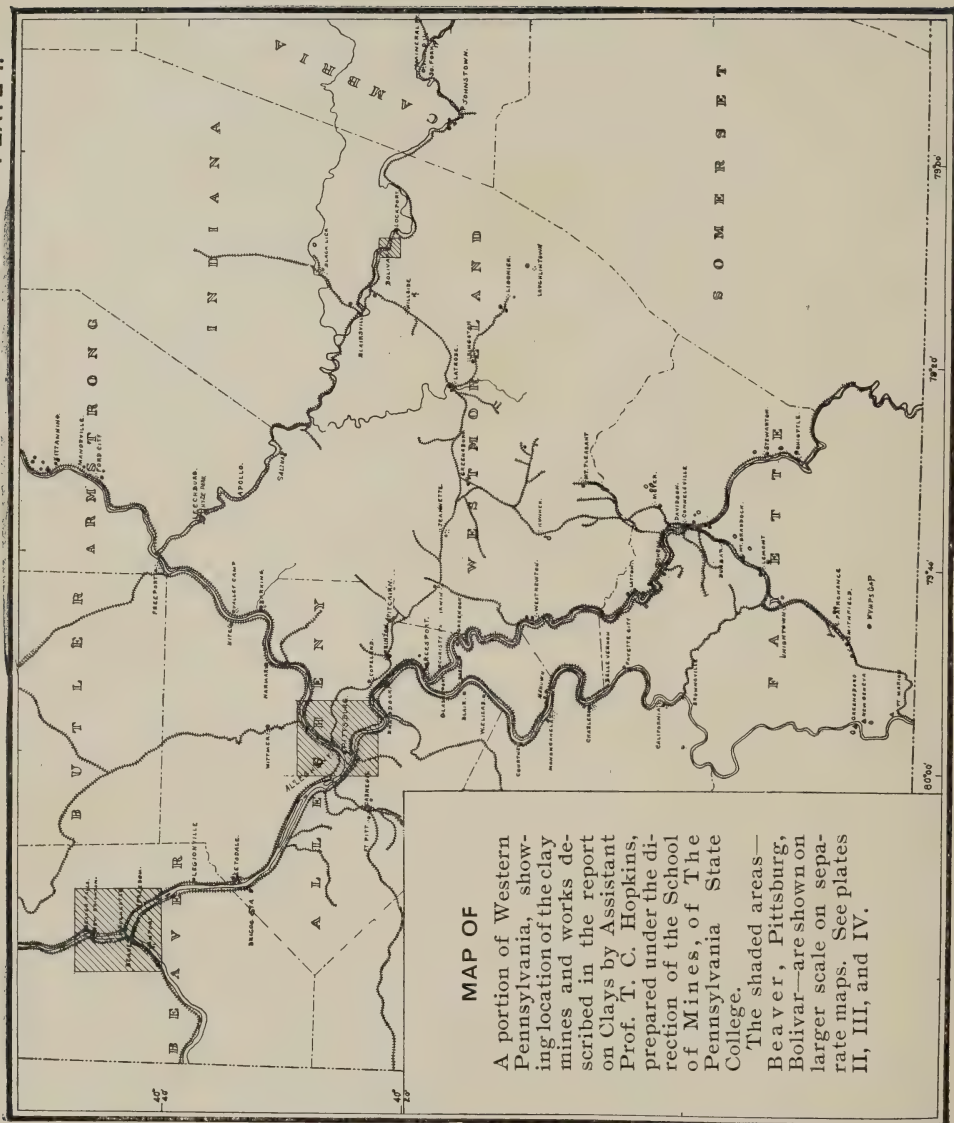
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THE CLAYS AND CLAY INDUSTRIES OF WEST-ERN PENNSYLVANIA.

By T. C. HOPKINS.

CHAPTER I.

GENERAL FEATURES OF CLAYS.

Clay is one of the most useful as well as one of the most abundant substances in nature. Because of certain valuable properties, it adapts itself to a great variety of uses; it is adapted to the simple and urgent needs of the savage and uncivilized tribes as well as to the more complex uses of civilized man. Untutored man finds it suited to his rude culinary needs in forming water vessels and cooking utensils, in constructing his rude dwellings and in making his pipes. As soon as he becomes more civilized and learns letters, he finds that one of the best and most durable means of preserving them is to burn them in clay. Some of the many uses of clay among highly civilized nations are mentioned and described in the following pages.

The scientific definition of clay from a chemical standpoint would be that it is a more or less pure variety of kaolin, the hydrous silicate of alumina. A popular definition would be that it is an earthy substance which becomes plastic when mixed with water.

Composition.—The base of all clays is the mineral kaolin or kaolinite which consists of alumina, silica, and water combined chemically in the proportion of one of the first to two of each of the second and third, Al_2O_3 , 2SiO_2 , $2\text{H}_2\text{O}$, or in the proportion by weight of silica 46.4, alumina 39.7, and water 13.9. A mineral compound containing only these substances in this ratio is sometimes called pure clay, but pure kaolin might be a better term. Kaolin may generally be recognized by its soapy or unctuous feel, its earthy odor when breathed upon, by giving off water when heated, and turning blue when heated before the blowpipe with cobalt nitrate. In many instances it becomes plastic when mixed with water.

Kaolin rarely occurs pure in nature. When the impurity or impurities are such as can be wholly or largely removed by a washing or other mechanical process it may still be mined or worked as kaolin. If the foreign substance or substances cannot be so removed, the material is then called clay, with the variety generally designated as brick clay, potter's clay, etc.

Free silica in the form of quartz or sand grains is one of the most common and abundant constituents of clays. Other common impurities are iron oxides, lime, magnesia, titanitic acid, and organic matter. Quartz, feldspar, mica, magnetite and limonite are the most common mineral impurities. The relative percentage of these different elements in large measure determines the variety and the use of the clay.

The foreign ingredients are sometimes classed as ((a) non-detrimental impurities and (b) detrimental or fluxing impurities.

But it is questionable whether such a division is a wise one; indeed, it is doubtful if the word impurity is thus used correctly, as what would be detrimental in one clay might be essential in another, so that fluxing and non-fluxing constituents are better terms. The iron, lime, magnesia and alkalis are the fluxing constituents and determine the fusibility of the clay. Of these, the alkalis are the strongest fluxes, but for most uses other than highly refractory ones, iron is the least desirable of the impurities because of the deep color it gives to the clay product.

Of the non-fluxing constituents silica is the most common. Silica occurs in three forms, first chemically combined with alumina in the base of the clay as an essential constituent; second, chemically combined with other bases forming other minerals; third, as free silica, quartz or sand.

The other common non-fluxing constituents are titanitic acid, water and carbonaceous material.

Shale is a stratified and a more or less hardened clay and while it may not differ essentially in composition from the unstratified clays, as a rule the shales have a larger percentage of foreign ingredients such as sand and mica scales. Many of the coal measure shales have a strong body yet fuse at high temperatures, thus rendering them valuable for the manufacture of vitrified brick, for which they are used extensively. Many of them are used for red brick and tile.

Origin of clays.—The original source of all the clays is to be sought in the igneous rocks, the decay of which furnishes the material for the sedimentary rocks. The most abundant minerals of the igneous rocks which are rich in alumina or clay material are the feldspars, which are silicates of alumina combined with potassa, soda, or lime. When these minerals are exposed to the disintegrating action of the atmospheric agencies the alkalis are leached out and the more resistant

portion, the silicate of alumina, takes up some water into its composition, but still remains insoluble and forms kaolin, the base of the clays. The feldspars and other kaolin-forming minerals are always accompanied by other minerals in the rock forms in which they occur in nature, so that any kaolin which occurs in the position of the original rock from which it was formed, will always be mixed with other mineral substances, such as quartz, magnetite, mica and many others in smaller quantities.

It frequently happens that these impurities are such that they can be separated from the kaolin by water and the stream or flood takes up and carries away as sediment all the decayed rock material and deposits in one place the gravel and heavier materials and in another the kaolin. Where the streams have not done this work in a satisfactory manner man utilizes the same forces and by washing, screening, settling and filtering, separates as far as possible the bulk of the impurities mixed with the kaolin.

As the elements of clay occur in all large bodies of igneous rocks in abundance, the clay materials occur in all soils or disintegrated materials resulting from them. Hence we find clay one of the most abundant and widely distributed substances in nature. But even comparatively pure deposits of the kaolin are few and limited in extent.

Properties of clay.—Clay has three important properties, which render it susceptible to a great many uses, making it almost invaluable to mankind:

First. Its plasticity when wet, by means of which it can be readily fashioned into multifold useful and ornamental forms.

Second. The durability of these forms when burnt, thus cheaply fixing and preserving in durable form the various shapes and designs.

Third. Its ability to withstand high temperatures without injury, thus giving us not only a fire-proof material for our dwellings but a material adapted to metallurgical and heating purposes.

While nearly all clays have these useful properties the different varieties do not have them in the same degree and there is quite a wide range both in the degree of plasticity and the degree of refractoriness, and as a rule the highly plastic clays are not highly refractory. One of the most refractory of clays, the flint fire-clay, is almost entirely devoid of plasticity.

Varieties.—Clays may be classified on several bases, the most common one, however, being that of usage. On this basis clays are classed as potter's clay, including China clay, fire-clay, brick or tile clay and shale. A more extended classification is sometimes used, but the numerous sub-varieties can be conveniently grouped under the three heads.

The following classification is sometimes used, based largely on the chemical and physical properties of the clays:

1. High Grade Clays.—Kaolin, china clay, porcelain clay, ball clay, potter's clay, fire-clay (flint and plastic), glass pot clay.

2. Low Grade Clays.—Brick clay, tile clay, siliceous clay, argillaceous shale, ferruginous shale.

H. M. Wheeler* gives the following classification of the clays.

1. White Ware.—Kaolin, china clay, ball clay.

2. Refractory.—Plastic fire-clay, flint clay, refractory shale.

3. Potter's.—Plastic clay and shale of moderate fusibility.

4. Vitrifying.—Paving brick clay and shale, sewer pipe clay and shale, roofing tile clay and shale.

5. Brick.—Brick clay and shales, terra cotta clay and shale, drain tile clay and shale.

6. Gumbo.—Burnt ballast clay.

7. Slip.—Clays of very easy fusibility.

The character and properties of the different kinds of clays are described in the following chapters.

Uses.—As can well be supposed from its properties, clay has more varied uses than almost any of our natural products. The most common uses of materials made from clay may be enumerated as follows:†

1. Domestic. Utensils, porcelain ware, china ware, granite or stone ware, yellow ware, earthen ware.

2. Structural. Brick, common, front or pressed, ornamental, hollow, vitrified, glazed, enameled, adobe, terra cotta, terra cotta lumber, roofing tile, drain tile, flooring tile, fireplace tile, chimney flues, chimney pots, door knobs, puddling, paving blocks, burnt clay for road metal and for ballast.

3. Agricultural. Drain tile, soil tile, irrigating tile, soil tempering, barn flooring.

4. Hydraulic Structures. Water conduits, reservoir lining, sewer pipe.

5. Sanitary Engineering. Granite ware, urinals, water closet bowls, earthen ware, sewer pipe, absorbent brick, drain tiles, ventilating flues.

6. Industrial Arts. China clay, chemist's crucibles and other apparatus, wall and writing paper filling, refractory clay, lime, cement and pottery kilns, puddling hearths, reverbatory and other smelting furnaces, assaying furnaces, gas retorts, stove and furnace linings, saggars, plugs, models, etc.

7. Ornamental and Aesthetic Uses. Tiling, ornamental pottery, terra cotta decoration, artists' moulding clay, base for retaining pigments.

*Missouri Geol. Surv., Vol. XI, p. 25.

†From the volume on Mineral Resources of the U. S. for 1891, page 475, published by the U. S. Geol. Survey. A few modern products made since 1891 have been added to the list as given in the Survey report.

8. Imitative Uses. Food adulterant, paint adulterant.

Value.—The total value of the clay products in the United States for 1896 is given† at \$62,341,853, of which 10.62 per cent. is pottery ware of different kinds, and 89.38 per cent. brick and tile.

The relative rank of Pennsylvania in the clay industries is shown by the following tabulation:

Value of the clay products of the United States for 1896,	\$62,341,853
Value of the clay products of Ohio for 1896, first rank,	9,949,571
Value of the clay products of Pennsylvania for 1896, second rank,	9,063,313
Value of the clay products of New York for 1896, third rank,	6,414,206
Value of the pottery ware in Ohio in 1896, first rank, ...	2,899,350
Value of the pottery ware in New Jersey in 1896, second rank,	1,069,142
Value of the pottery ware in Pennsylvania in 1896, third rank,	617,601
Value of fire brick in Pennsylvania, first rank,	2,083,414
Value of fire brick in New Jersey, second rank,	604,983
Value of vitrified paving brick, Ohio, first rank,	619,463
Value of vitrified paving brick, Illinois, second rank, ...	486,519
Value of vitrified paving brick, Pennsylvania, third rank,	404,182
Value of pressed and ornamental brick, Pennsylvania, first rank,	662,188
Value of pressed and ornamental brick, New Jersey, second rank,	340,919
Value of common brick, New York, first rank,	4,141,973
Value of common brick, Pennsylvania, second rank, ...	4,118,206
Value of common brick, Massachusetts, third rank, ...	1,601,537
Value of total brick and tile product for 1896, Pennsylvania, first rank,	8,445,712
Value of total brick and tile product for 1896, Ohio, second rank,	7,050,221

From the above it will be seen that Pennsylvania ranks first among the states of the Union in the value of its fire brick, pressed and ornamental brick and in the total brick product. It ranks second in production of common brick and in the total value of all clay products, and third in pottery ware and in vitrified paving brick. This shows not only the high rank of the State of Pennsylvania among the other states in the value of its clay products but also the great value of the clay products in the State as compared with the other resources.

*In the Mineral Resources, 18th Annual Report, U. S. Geol. Survey. See tables I to X, in Chapter IX, of this report for further statistics of the clay industries in Pennsylvania.

Large as the industries are they are capable of much greater extension, especially in paving brick, high grade building brick, ornamental brick, terra cotta ware, tiling and different grades of pottery ware. In the fire brick and common red brick industries the supply is equal to the demand and there is not the same prospect for greatly increasing demand as in the other lines.

CHAPTER II.

POTTERIES AND ALLIED INDUSTRIES.

The pottery ware includes both the highest and the lowest types of the clay workers' skill. It includes the most primitive works of uncivilized man and the highest skill of the most cultivated. There are many centuries of experimenting between the crude bowls and ornaments of the savage and the elegant vases or delicate china ware of the white man. The aggregate value of the product of the potteries is much less than that of the brick product but the price per ton is much higher and varieties in shapes and uses are almost innumerable.

All the pottery industries are commonly divided into four classes, which in a more minute classification might be further separated into numerous sub-classes:

1. Red earthenware.
2. Stoneware.
3. Yellow or Rockingham ware.
4. White ware, including (a) C. C. ware, (b) white granite, (c) semi-porcelain, and (d) porcelain.

The distinctions are based partly on methods of burning and glazing the ware, and partly on the kind of clay used and the care and skill used in preparing it.

1. Earthenware is probably the lowest form of pottery and can be made with proper precautions from almost any of the common yellow clays. It differs from common stoneware in being burned at a lower temperature and in being softer and more porous (more earthy). The only form of earthenware manufactured in Western Pennsylvania at present is red flower pots made at Oak Hill pottery, at New Brighton, and the Erb pottery, Pittsburgh. Drain tile might properly be included in this class, but it is commonly classed with the hollow ware. There is but one factory making drain tile in the part of Pennsylvania covered by this report, viz: Kittanning Clay Manufacturing Co., at Kittanning.

2. Stoneware is probably the largest pottery industry in Western Pennsylvania. There are seven manufactories of stoneware in active operation and several idle ones. Stoneware differs from earthenware in that it is always glazed and the body of the ware at least partly vitrified and it is distinguished from Rockingham or yellow

ware in that the burning and glazing is done in one operation instead of two.

Much of the stoneware is given a brown glaze on the interior by the use of slip clay and a salt glaze on the outside, generally of gray or bluish color, depending upon the character of the clay. Other glazes formed by mixtures of different kinds are sometimes used.

The essential qualities of a good stoneware clay as given by Prof. Orton,* are:

1. It must be plastic so that it can be readily molded into the desired shape.

2. It must be refractory enough to stand up well and keep its shape at a temperature sufficient to melt the glazes.

3. While retaining its shape it ought to undergo a process of vitrification, or probably better lithification, that will not only give it greater strength but render it impervious to water.

4. It should burn with a clear and uniform tint.

5. The ware when burnt should be free from blotches, pimples or blisters.

The average of ten accurate and carefully made analyses of pottery clays in use for stoneware, gives the following result:

Analysis of average stoneware clay.

Clay base,	56.65 per cent.
Sandy matter,	37.45 per cent.
Fluxing matter,	4.44 per cent.
Moisture,	1.57 per cent.
Total silica,	65.00 per cent.

The extremes, however, vary widely from this average and the variation determines largely the character of the clay. Thus all the lighter colored wares demand a clay free from iron or nearly so. Some wares require a clay with a strong body, others require a liberal percentage of fluxes.

The clay is prepared for use either by grinding or by washing. Both processes are used in the Pennsylvania potteries. The grinding is commonly done in a wet pan, somewhat similar to that described on page 55, but it is commonly lighter and geared differently and known as the tracer or chasing mill.

When the clay is washed it is first put into the blunger where it is reduced to a thin slip or fluid pulp, which is transferred to the screens where the pebbles and coarse material are separated. The fine clay and liquid are run then into an agitator from which it is pumped into the filter press. The clay comes from the filter press in flat leaves or plates and is tempered for use in a pug mill.

Turning.—There are three methods of fashioning the ware from the clay: 1. Turning the clay by hand or jigging was the first method

*Report of the Geol. Sur. of Ohio, Vol. VII, page 92, 1893.

used, and until comparatively recent times was the only method. The clay is first wedged by cutting with a wire and kneading, the lump of clay is then slapped on a revolving horizontal disc, which is turned by the foot, "kicking," or by machinery. By pressure of the hand on the revolving mass it is made to take the desired form by the skilled workman. It requires great mechanical skill, that usually comes from long experience, to make an expert turner, a skill in which the workmen take a just pride.

2. A large part of the stoneware, particularly the smaller forms, is now made by a jollying process, in which the clay is placed in the bottom of a plaster-of-Paris cast, the inside of which has the form of the outside of the ware; this is made to revolve on a disc as before. The workman with his hand forces the clay to cover the inside of the cast, then fashions the interior, by a jointed lever, the pull down. See fig. I. When the operation is complete the mold is removed to the drying room, where after partial drying the vessel is removed

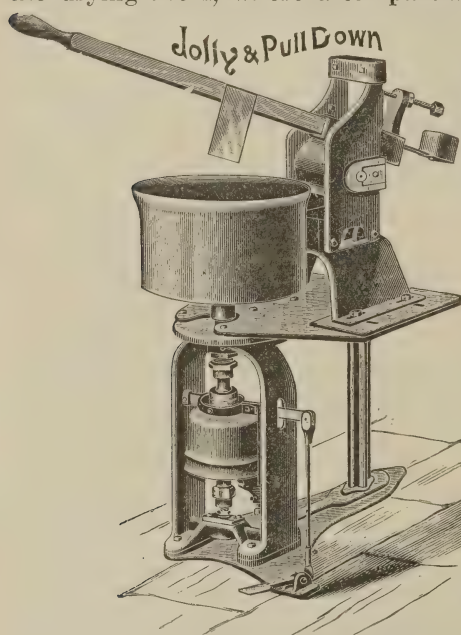


Fig. 1. Jolly and pull down for turning pottery ware.

from the mold, the handles or intricate parts, if any, are put on and it is smoothed and trimmed up ready for the burning kiln. This process is much more rapid than the hand process and is replacing it in large measure in all the larger factories.

The third method referred to is casting, in which the clay is reduced to a slip or paste and poured into the mould prepared for it. This is adapted to intricate designs and high grade ware.*

In the potteries in the Monongahela valley the ware is all turned by hand, in the larger potteries at New Brighton the second and third processes are used, although

there is some turned by hand in all works, large or small, where miscellaneous material is made.

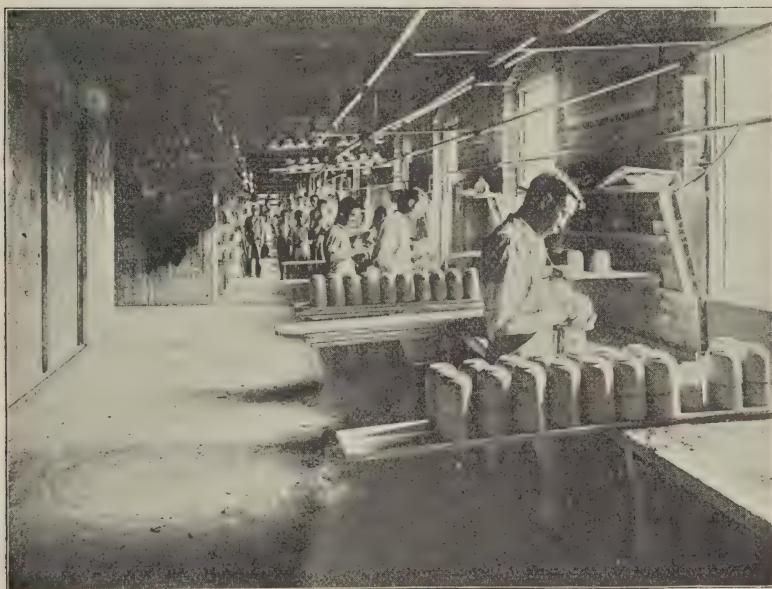
Glazing.—The next stage in the manufacture of stoneware after the partial air-drying is the glazing, which is usually done with salt

*A new process recently discovered but not extensively used as yet, and applicable only to certain grades of ware, consists in melting the materials and pouring into molds in a fused condition.

or with a more fusible clay called "slip clay." The most common practice is to use a slip glaze on the interior and a salt glaze outside, although in some grades of ware slips are used for the outside as well as the inside. The slip is mixed thin and sprayed over the interior of the ware, which is then ready for the kiln.

The salt glaze is obtained by throwing common salt on the fire at a certain stage in the burning and the fumes of the salt combining with the clay form a glassy silicate coating.

So far as known there is no slip clay obtained in this State. The best known in this country is the Albany slip, from Albany, New York, which is the one used almost exclusively among the potteries



Illustrating the processes of making china ware.

Fig. 2. Jigger department—clay shop.

in Western Pennsylvania, but some slips imported from foreign countries are used in part in some of the factories. Artificial slips are frequently used by the more skilled potters for certain grades of ware by mixing other substances with the natural slip clays, to vary the grade of fusibility or to give different colors.

The question of slips and glazes is intimately associated with other classes of pottery, and enameled brick and glazed tiling. It probably calls for more technical skill than any other phase of the industries, especially in the ornamental ware.

Burning.—The burning of the large ware, as jugs and jars, is conducted in the open kilns by properly stacking or setting the ware and burning similar to brick, regulating the temperature according to the character of the ware and clay. The smaller and more delicate ware is burnt in saggars to protect the ware from the flames. Great care and skill, such as is acquired only by practice, is necessary in setting and burning the ware.

A list of the potteries in western Pennsylvania is given in chapter IX.

Yellow and Rockingham Ware.—Yellow ware differs from stoneware in the manner in which it is burnt. In stoneware the process



Illustrating the processes of making china ware.

Fig. 3. Glazing department, dipping room.

is completed in one operation. Yellow ware is first burnt in the biscuit kiln to develop the body of the ware and then burnt again to develop the glaze. The same clay may be used for both stoneware and yellow ware, but a less refractory clay may be used for the yellow or Rockingham ware because the glazes fuse at a lower temperature than the stoneware glazes.

But little yellow ware is manufactured in western Pennsylvania. The Beaver Valley Porcelain Co., operated at New Brighton for several years, manufacturing washboards and soap dishes of yellow ware, but the company has discontinued. There is a new company starting this year (1897) that, it is said, will manufacture yellow ware in part.

White Ware.—The white ware industry, including the C. C. ware, white granite, semi-porcelain and porcelain, stands at the head of the list of pottery wares in the purity of the clays and skill of the operator required for its successful operation.

The technique of this industry is too varied and complicated to justify a description here. It requires a more costly and expensive equipment, calling for a large capital and more technical knowledge to carry on the industry than the cheaper stoneware, hence there are not so many small operators. There are two large and prosperous white ware factories in western Pennsylvania: The Mayer Pottery Co., located at Beaver Falls, and the Wick China Co., at



Illustrating the processes of making china ware.

Fig. 4. View at the gloss kilns.

Kittanning, both described in the following chapter, and the newspapers report another about to start at Ford City.

This industry differs from the other grades of pottery ware in the complexity of the mix or material used. Instead of using a natural clay alone, mixtures of clay, kaolin, feldspar and quartz are used, the clay in some cases forming a comparatively small percentage of the total. The body used in china ware by one company is plastic or ball clay (imported) 16 per cent., feldspar 14 per cent., kaolin 35 per cent., flint (quartz) 35 per cent. This of course will vary greatly for different grades of ware and even in the same ware by different companies.

None of these materials is obtained in western Pennsylvania, the

only native clay product they use being the clay used in making sag-gars. The plastic or ball clay is obtained in part from other states and in part from England and Germany. They are now experimenting with a view to using more of the domestic clays.

The kaolin is obtained from Blair, Delaware and Chester counties, Pennsylvania, Florida, North Carolina and Kentucky. The kaolin deposits of Pennsylvania are described in the annual report for 1885 of the second Pennsylvania Geological Survey.



Illustrating the processes of making china ware.

Fig. 5. View in the biscuit ware room.

Feldspar and flint are obtained from eastern Pennsylvania and other eastern states.

The sewer pipe and flue lining industry is allied in some respects to the brick and tile industry and in some respects to the potteries. There is but one factory of each in western Pennsylvania, those belonging to the Pittsburgh Clay Manufacturing Co., at New Brighton, which are described in the next chapter.

CHAPTER III.

THE POTTERY INDUSTRIES OF WESTERN PENNSYLVANIA.

THE MONONGAHELA VALLEY POTTERIES.

New Geneva, Pa.—The pottery in New Geneva was built in 1854, and was operated for a time by each of the following parties: Mr.

Dilliner, Mr. Everhart and Mr. Atchison. Mr. Dilliner was probably the first, yet the party giving the information was uncertain in regard to the order in which they operated. Mr. A. Conrad was the next proprietor, who sold out in 1882 to R. T. Williams, who operated the works until the present year, 1897. Since April, 1897, they have been operated by C. L. Williams & Co., but the clay deposit still remains in the possession of the R. T. Williams estate.

The clay which they are working at present comes from a river terrace deposit near the top of the river hill, about a mile and a half east of south of the works, on the east side of the Monongahela river. The workable clay is six to eight feet thick, a very plastic blue clay which contains numerous yellow stains near the base and a thin layer of black carbonaceous matter at the top. Closely associated with the black streak is a band of whitish gypsum crystals. Overlying the black streak there is one to two feet of sandy clay overlain by three to five feet of sandy material containing numerous water-worn and angular boulders. The clay is quarried by hand and hauled by wagon to the works at New Geneva.

Clay was formerly obtained in large quantities from a pit about a quarter of a mile west of the present one on the west side of the wagon road and nearer the river than the present working.

The company makes blue stoneware, such as jugs, jars, etc., with a salt glaze on the outside and a brown glaze formed by the use of the Albany slip clay on the inside. The largest trade is in jugs and Pittsburgh is the chief market, but they have considerable trade in the intervening river towns and points along the Monongahela southwest division of the Pennsylvania Railroad.

They have two kilns and a capacity of 200,000 gallons of ware per year. The ware is all turned by hand and the price is a little higher than that at the New Brighton works, where the ware is nearly all jollied. The large ware is sold by the gallon, and small ware by the dozen.

Both coal and wood are used for fuel. Wood is used for finishing the burning it is said, because it gives more blaze than coal, enabling the burner to finish the ware in better shape.

Greensboro, Pa.—Hamilton & Jones constructed a pottery of five kilns on the lower edge of Greensboro in 1866, and operated it from that time until April of the present year (1897), when it was destroyed by fire. Shortly after the fire they rented the pottery on the river bank a short distance below the boat-landing in the village of Greensboro.

This pottery now operated by Hamilton & Jones is said to have been constructed in 1857 or 1858 by W. L. Hamilton, who came from Bridgewater, near New Brighton, abandoning his pottery at that place. No definite information could be obtained as to the length

of time Mr. Hamilton operated the pottery or what other parties were in the business. For a number of years previous to 1897 it had been owned and operated by the firm of Williams & Reppert. After the fire had destroyed the works of Hamilton & Jones, Williams & Reppert wishing to go out of the business, rented to Hamilton & Jones their pottery in Greensboro. The pottery is smaller than the one that burned, having but two kilns with a weekly capacity of about 4,300 gallons. Like the New Geneva pottery, they use both wood and coal in burning. It takes 36 to 40 hours to burn a kiln which would be burnt in 24 hours when they used wood alone, as they did a few years ago.



Illustrating the processes of making china ware.

Fig. 6. View in the printing department—decorating shop.

They make jugs, jars, flower pots, etc., but the principal trade is in jugs.

The clay is obtained in part from the R. T. Williams' estate, from the same pit as that from which the clay is obtained for the New Geneva pottery. In part the clay is obtained from their own (Hamilton & Jones) pit, located two miles west of Greensboro, about a quarter of a mile north of the cemetery. The pit has not been worked for some months, and the debris has fallen in, concealing the clay so that neither the quantity nor the quality of it could be observed. It is a terrace deposit like the New Geneva clay as shown by overlying material, which consists of sand and boulders, many of which are waterworn. This clay contains more sand than the Williams'

clay and does not make good pottery by itself, but mixed with the Williams' clay it is said by the potters using it to improve the quality of it and make better ware than either clay alone.

Port Marion, Pa.—On the east bank of the Monongahela river, about one mile below Port Marion and about four miles above New Geneva is a small pottery containing one kiln with a capacity of 1,500 gallons per week. It was erected by Dilliner & Dills early in 1896, and operated by them about one year. In July, 1897, it started again under a new company as the Union Pottery Co., consisting of J. E. Encix, F. L. Cleavenger, J. A. Rumble and A. J. Hayden. They have all had more or less experience and some of them are skilled potters. They do all the work themselves and will no doubt do a successful business. They make the following in blue stoneware: jugs, jars,



Illustrating the processes of making china ware.

Fig. 7. View in the filling-in department—decorating shop.

milk pans, churns and covers, butter jars, preserve jars, fruit jars, pitchers, cuspidors, chambers, beer mugs and bean pots.

There is a boat-landing at the pottery, Protson's landing, and most of their ware is shipped by boat. That shipped by rail is hauled to Port Marion, a mile distant, and shipped on the Baltimore and Ohio Railroad.

The clay mine was not visited by the writer. It is said to be about

one mile east of the shop and to occur in a bed about four feet thick. Samples of the clay resemble that at New Geneva. As in the other potteries, the Albany slip is used for the inside brown glaze and salt for the outside blue-gray glaze.

2. KITTANNING-LIGONIER.

Kittanning, Pa.—The Wick China Co., at Kittanning, Pa., claims to be the second largest china factory in the United States. The works are situated close to the tracks of the Allegheny Valley railroad, about half a mile north of Kittanning. They make plain and decorated ironstone chinaware of different kinds and in large quantities. They have eight kilns in use and employ a force of about 350 men, boys and girls.



Fig. 8. View of works on the Allegheny Valley railroad near Kittanning.

The bulk of their ware is made from imported clay. They use some kaolin from Brandywine Summit in this State and obtain feldspar and flint from Toughkenamon, Pa. The native clay obtained from the mines of the Kittanning Fire Brick and Clay Co., is used in making the saggars in which the ware is burnt. It is mixed with clay from New Jersey, between 200 and 300 tons of the native clay being used annually.

The works were started in 1890, and have been in active operation



Fig. 9. Pressing department—clay shop.



Fig. 10. Biscuit kiln placing.
Illustrating the processes of making china ware.

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since that time. The products are shipped to all parts of the United States.

Ligonier.—There was a small pottery in operation for many years at Ligonier, that was started in 1840. The name of the founder could not be ascertained but Mr. John Ware operated it from 1857, until after the war. Mr. Houston Cochran, now living in Cleveland, Ohio, took possession of the works in 1866, and operated them for a number of years. Just when the pottery was abandoned could not be ascertained. The only ware made was crocks, or, as the more modern potter would say, jars. The material used it is said was a blue clay, hauled by wagon from the Denny estate at the old toll gate, about a mile north of Ligonier.



Fig. 11. Glass wareroom, Kittanning, Pa.

3. PITTSBURG.

The Star Encaustic Tile Company's factory is located in Pittsburgh, Pa., at the corner of Bluff and Gist streets. The business was started in 1876 as the Pittsburgh Encaustic Tile Co., Limited, and was re-organized in 1882 under the present name, and under the present management. The officers of the company are John C. Aldrich, President, Wm. R. Thompson, Secretary and Treasurer, and Samuel Keys, Superintendent. There are several other factories in the United States

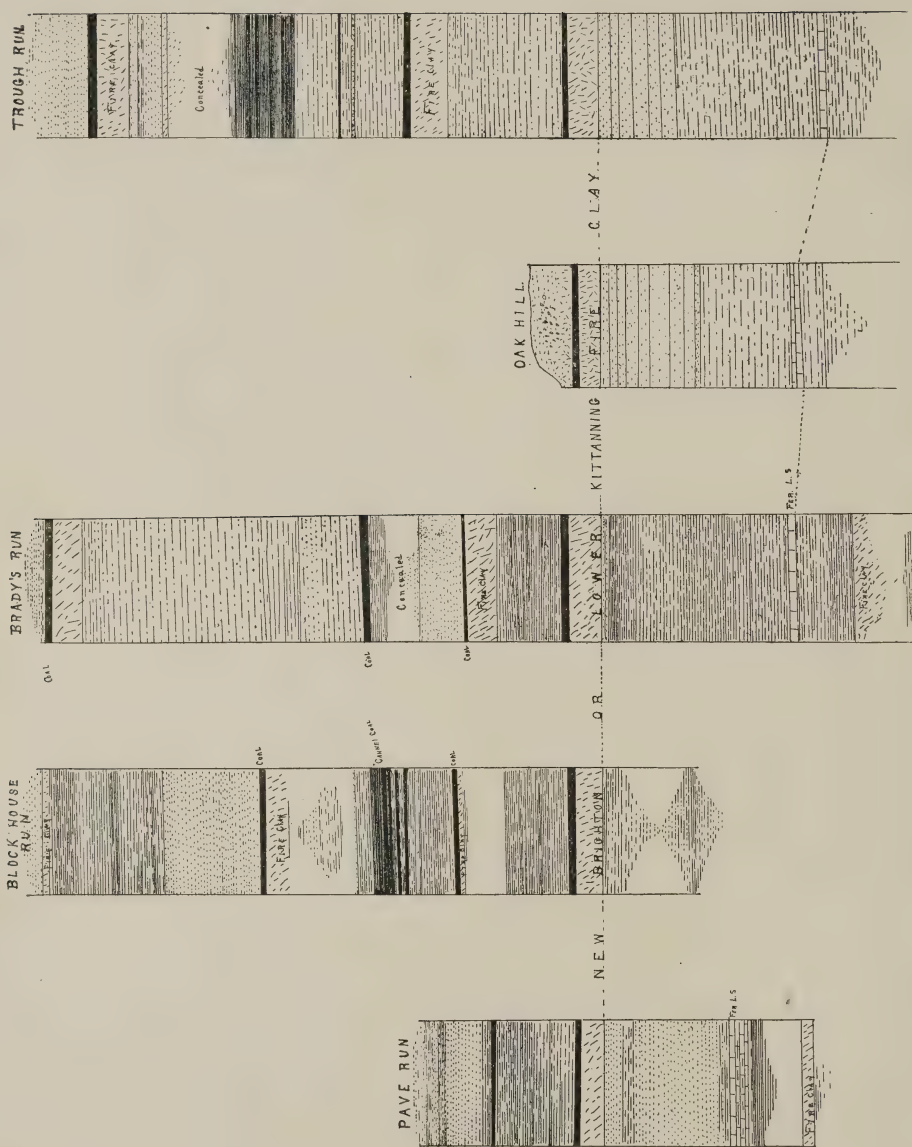


Fig. 12. Series of vertical sections in the immediate vicinity of New Brighton, Pa., showing the relation of the clay beds to the inclosing strata.

making the enameled and glazed tile, three of which also make the unglazed tile, but this company is said to be the only one which confines its operations entirely to making a full line of unglazed tile. They constantly carry a large stock of manufactured goods, and are shipping to all parts of the U. S., and to some extent to Canada. They have also made some shipments to Mexico and South America. The clays used by the company are all domestic, and the two kinds of which the largest quantities are used are obtained, the one near the factory from the Lower Barren Coal Measures, and the other in New Brighton, Beaver county, from the Kittanning bed of the Lower Productive Measures. They use a limited quantity of a clay obtained in the Allegheny mountains, near Hollidaysburg, Pa., and a small quantity of white Florida clay or kaolin. No imported clay is used. The company furnished a handsome tile floor for the space allotted to Pennsylvania in the Mines and Mining Building at the World's Fair, in Chicago, in 1893. The State made this floor and a large lot of samples of tile and clays used by the company formed a part of its exhibit of the mineral resources of the State. Part of this exhibit is now in the museum at State College.

Erb Pottery.—The Erb Pottery is at 26th and Sarah streets, South Side, Pittsburgh. They make red flower pots only and apparently these only on a small scale. No further data could be obtained concerning the works.

4. NEW BRIGHTON AND VICINITY.

The clays.—There are not less than seven different beds of clay in the vicinity of New Brighton. While clay has been used from four different beds, besides some shale from different horizons, the bulk of the clay mined is taken from a single bed, known as the New Brighton or the Lower Kittanning clay, which lies immediately underneath the Lower Kittanning coal.

The accompanying illustration (fig. 12) gives several sections made at different points in this vicinity showing the relations of the clay beds. The lowest bed now exposed at any of the points observed is the Clarion bed, but there is said to be a still lower bed that has been opened near the mouth of Brady's run that is thought to occur at the horizon of Brookville coal and clay, immediately overlying the Homewood sandstone.

The Clarion clay has been mined and used to some extent by the Fallston Pottery Co., on the east side of Brady's run, where it lies in a bed about twelve feet thick at the base of the hill at the pottery works. A drift has been run into the hill about fifty yards and shows the clay to run rather uniform in thickness and character. It

was used by the pottery company, but the works are not in operation at present and nothing definite could be learned concerning the results. Some parties interested in other mines say it did not make good ware; other parties say it is better clay than the Kittanning. The Clarion clay is exposed near the mouth of a small ravine on the west side of Brady's run, less than half a mile above the pottery works. There is another exposure in the bottom of Pave run, at the Enterprise Pottery. S. Barnes & Co. state that this clay occurs underneath their works near Rochester, and that they at one time mined a small quantity of it on the river bank opposite their works. It no doubt occurs at many other points in the valley, but has not been opened or developed at any other points. Probably the reason it has not been exploited more thoroughly is that it lies so low that in most places it could be obtained only by shafting, and the Lower Kittanning bed furnishes an excellent clay that can be obtained by drifting.

The Lower Kittanning (Kittanning) clay, is by far the most important bed of clay in the Beaver valley, as it is further down the Ohio valley in the East Liverpool region. It furnishes almost all the clay used in the different potteries and hollow ware works at New Brighton and vicinity, except the ironstone china ware. It also furnishes the greater part of the clay in the large firebrick, paving brick and building brick works in this vicinity.

According to the Ohio state reports it is the Lower Kittanning clay that furnishes the bulk of the product in eastern and southern Ohio, where it is used in even larger quantities than it is in the Beaver valley.

The clay is mined for the Enterprise Pottery Co. by Mr. Emmanuel Evans at the works. Sherwood Bros. mine their own clay at the works. A. F. Smith & Son furnish clay to the porcelain works and in part to some of the other potteries at New Brighton, also to the tile works at Beaver Falls and Pittsburgh, besides shipping clay to many other points. The Pittsburgh Clay Manufacturing Company mine the Lower Kittanning clay for their own use in two shafts near the sewer pipe and flue lining works and in another smaller opening near their Oak Hill pottery. Other points in the vicinity where this clay has been opened and worked are at the works of the Fallston Fire Clay Co., the Fallston Pottery Co., the Brady Run Fire Clay Co., all on Co., the Fallston Pottery Co., the Brady's Run Fire Clay Co., all on Dando & Bro. and two works of the Park Fire Clay Co., on Crow's run, near Freedom; Brady's Run Fire Clay Co., and Welch, Gloninger & Co., at Monaca; the Vanport Fire Clay Co., and Welch, Gloninger & Co., at Vanport; the Park Fire Clay Co. below Vanport; the Stahl Fire Brick Co. below Beaver on the south side of the Ohio river. It was formerly worked by L. S. McKallip & Co., on the south

side of the Ohio river, opposite Beaver and by the Keystone Pottery Co. at Rochester. Mr. White and Mr. Fish have both opened this clay on their property at Bennetts run above New Brighton on the east side of the Beaver river. Mr. White has mined the coal and taken out some of the clay with the coal. Mr. Fish has been taking the coal from above the clay and the flagstone underneath the clay but has made no use of the clay as yet.

The clay forms a continuous bed throughout this region and will no doubt be opened at other points in the course of time. The clay bed is probably continuous from the Beaver valley region to East Liverpool, Ohio, where it is used so extensively. The writer did not have the opportunity to explore the region west of the Vanport dam, but was informed by local geologists that the conditions are not favorable for working the clay, as it is concealed under a heavy drift or river terrace deposit and it is said that the clay is not utilized at all in this intervening region, that is, between the Vanport works and those in Ohio.

The clay runs rather uniform in thickness throughout the Beaver valley region, but the thickness mined at the different works varies. This is partly due to the fact that the bed varies in thickness and partly to the fact that the lower part of the bed grades almost imperceptibly in places from the smooth plastic clay into a flaggy sandstone. The brick works can use more of the sand than the potteries and some grades of the pottery ware can stand more than other grades. The upper part of the bed is remarkably even, the coal bed overlying it preserving an almost uniform thickness of 22 inches throughout the area (see fig. 12), but there are occasional rolls in the bottom of the clay bed extending in places two feet or more into the bed. The thickness of the clay mined thus varies from four to nine feet at different points, averaging about six feet, one company claiming a thickness of sixteen feet, which presumably includes considerable of the underlying sandstone. The thickness worked by some of the leading companies at their mines is as follows:

Sherwood Bros, seven feet.

Enterprise Pottery Co. eight feet.

Sewer Pipe Works six to seven feet.

A. F. Smith & Son six to seven feet.

Ingram & Co. seven to eight feet.

Welch, Gloninger & Co., Monaca, six feet.

Brady's Run Fire Brick Co., Monaca, sixteen (?) feet.

Brady's Run Fire Brick Co., Monaca, sixteen feet.

Stahl Fire Brick Co. six feet.

The clay shows no evidence of lamination except in the sandy layers at the base. It comes from the mines in moderately hard, irregular lumps, which on exposure to the weather quickly crumble

into fragments and later into soft, plastic clay. Most of the companies keep a large stock of clay on hand so that it can be exposed to the weather several months before using it, as it works so much better than the fresh clay, which is seldom used except in case of necessity. The clay is ground in a dry pan and screened before using and in the potteries and tile works it is washed and screened.

This bed of clay has been a great source of wealth in the Beaver valley and vicinity and no doubt will continue so for many years to come.

The commercial importance of the Lower Kittanning clay in Ohio is shown by the following extract from the Ohio state report.*

"Under this head we come to the great clay horizon of the state. Its importance far outweighs that of any other clay seam of our scale. Indeed, it is probably equal in value, to all other sources of clay in the Coal Measures combined. In its more important fields it ranges in thickness between eight and thirty feet. In some districts it is merged, with only the interruption of the Lower Kittanning coal seam, into the clays that belong next in the ascending series, viz: those which come in below the middle Kittanning coal. In this case the combined deposits constitute a section measuring not less than fifty feet. The Kittanning clay horizon proper is seen at its best where it enters the state from Pennsylvania, and again where it leaves the state in its extension into Kentucky.

"As a rule, the horizon produces a white plastic clay, almost always of fair quality and, in places, of the highest excellence. The plastic clay is the foundation of the great pottery industries of eastern Ohio, where it is worked on a very large scale. A second, and even more valuable phase of the clay is found at a few points in Stark, Tuscarawas and Carroll counties. The formation here yields a hard or flint fire-clay of quality scarcely inferior to the best clays of the country. This phase is known under the name of the Mineral Point clay. It is largely worked and manufactured at the village of this name, and at Canal Dover, as well, and the products have an excellent name in all markets, for their refractory quality.

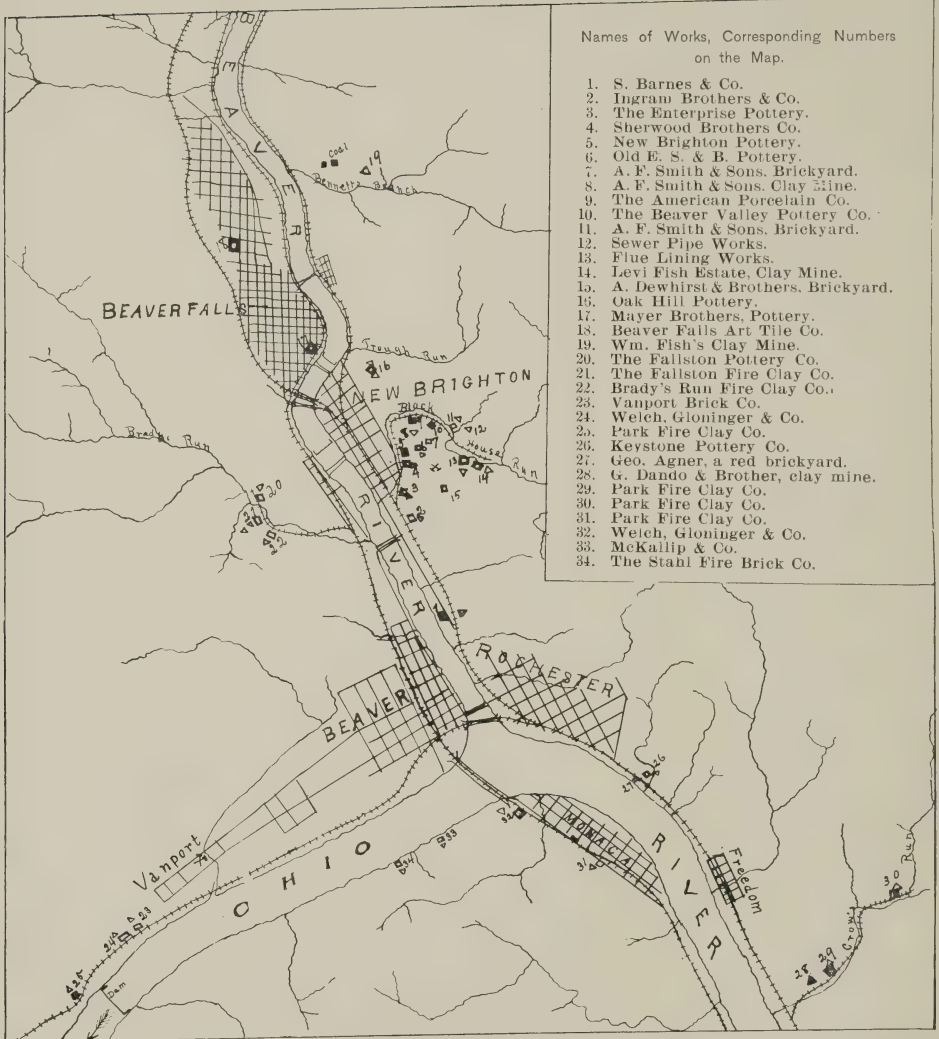
"Analyses of the Mineral Point clay have been often published. A single one will be quoted here, fairly representing the formation (Lord). The figures show a clay of great excellence:

"Combined silica,	35.39 per cent.
"Alumina,	31.84 per cent.
"Combined water,	11.68 per cent.
"Percentage kaolinite base,	78.91 per cent.
"Free silica,	17.13 per cent.
"Titanic acid,	1.68 per cent.

*Ohio State Geol. Survey Report, Vol. VII, p. 65.

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PLATE II.



Names of Works, Corresponding Numbers on the Map.

1. S. Barnes & Co.
2. Ingram Brothers & Co.
3. The Enterprise Pottery.
4. Sherwood Brothers Co.
5. New Brighton Pottery.
6. Old E. S. & B. Pottery.
7. A. F. Smith & Sons Brickyard.
8. A. F. Smith & Sons Clay Mine.
9. The American Porcelain Co.
10. The Beaver Valley Pottery Co.
11. A. F. Smith & Sons Brickyard.
12. Sewer Pipe Works.
13. Flue Lining Works.
14. Levi Fish Estate Clay Mine.
15. A. Dewhirst & Brothers Brickyard.
16. Oak Hill Pottery.
17. Mayer Brothers Pottery.
18. Beaver Falls Art Tile Co.
19. Wm. Fish's Clay Mine.
20. The Fallston Pottery Co.
21. The Fallston Fire Clay Co.
22. Brady's Run Fire Clay Co.
23. Vainport Brick Co.
24. Welch, Gloninger & Co.
25. Park Fire Clay Co.
26. Keystone Pottery Co.
27. Geo. Agner, a red brickyard.
28. G. Dando & Brother, clay mine.
29. Park Fire Clay Co.
30. Park Fire Clay Co.
31. Park Fire Clay Co.
32. Welch, Gloninger & Co.
33. McKallip & Co.
34. The Stahl Fire Brick Co.

MAP OF NEW BRIGHTON AND VICINITY

Showing location of Clay Mines and Works. Prepared under the direction of the School of Mines of The Pennsylvania State College, by Assistant Prof. T. C. Hopkins. Base of the map adapted from map of Beaver County compiled by H. T. Barker.

"Sandy material (total),	18.81 per cent.
"Sesquioxide of iron,	0.67 per cent.
"Lime,	0.50 per cent.
"Magnesia,	0.19 per cent.
"Potash,	0.59 per cent.

"Of the ordinary phase of the deposit, viz: the white plastic variety, abundant analyses are at hand, but it is hard to find any one that can be called thoroughly representative. In the discussion of clays in manufactures in a succeeding chapter, numerous analyses will be found. The products of this horizon are used on a great scale in the finer pottery manufacture for saggars, also in part for the manufacture of Rockingham and yellow ware; and, lower still in the scale of value, for stoneware. These clays are a main dependence of great sewer pipe factories, and also are sometimes used in making fire brick of ordinary quality. An enormous amount is now being turned to account in the manufacture of paving brick. By reason of the uses and adaptations above named, the Kittanning clay seems certain to hold for all time to come the first place in our clay horizons."

Middle and Upper Kittanning clays.—Clay occurs in the Beaver valley in several localities at horizons above the Lower Kittanning supposed to correspond to the horizons of the Middle and Upper Kittanning coal, but so far as known to the writer they have not been utilized in this region. Their relative positions are shown in the sections on figure 12.

Lower Freeport clay.—A bed of clay supposed to be at the horizon of the Lower Freeport occurs at several places and has been mined to considerable extent in one locality by the Fallston Fire Clay Co. They use it to mix with Lower Kittanning clay in different proportions to get different grades of brick. In several places the outcrop of this clay shows a very plastic light colored clay of great promise, but in most places it contains scattered fragments of iron oxide that stain it more or less. It is questionable how much of the iron could be removed by washing. If it could all be removed economically the clay would make a good plastic clay. If it could not be removed it might still be a valuable clay for brick making.

At the sewer pipe works, the Pittsburgh Clay Manufacturing Co. has mined a clay bed at a still higher horizon, which was not seen by the writer but which Mr. Brown, the superintendent, thinks belongs to the Mahoning horizon. They do not use it at present and have not for several years.

Terrace clay.—At the Oak Hill pottery the Pittsburgh Clay Manufacturing Co. use a clay from the river terrace deposit at the works. They mix it in certain proportions with the Lower Kittanning clay mined at the same place. It contains more iron than the Kittanning

clay and gives the red color to the flower pots made of it. The Terrace clays have been used at several other points on the east side of New Brighton for making red brick and it was used at one time by Elverson & Sherwood, on Block House run, for making red flower pots.

*Analysis of terrace clay at New Brighton, Elverson & Sherwood:**

	Per Cent.
Silica (SiO_2),	67.780
Alumina (Al^2O_3),	16.290
Titanic acid (TiO_2),	.780
Iron oxide (Fe^2O_3),	4.570
Lime (CaO),	.600
Magnesia (MgO),	.727
Alkalies,	2.001
Water,	6.340
Total,	99.088

POTTERIES AT NEW BRIGHTON AND VICINITY.

The pottery industry at New Brighton and vicinity is a very important one. There are three large stoneware factories in active operation in New Brighton, and one now idle at Fallston, near by, a large white ware or stone china ware factory at Beaver Falls, a flower pot factory, a hollow ware factory, a sewer pipe works, a flue lining works, all in active operation at New Brighton, a washboard factory now idle, and a small pottery just starting, an art tile factory at Beaver Falls and large quantities of clay shipped in a raw state to distant points. It will thus be seen that there are nine large factories in active operation and two idle at present, all of which use the native clay more or less, one only in small part but most of them almost entirely.

Historical.—The first attempt at pottery-making in the Beaver valley, so far as can be ascertained, was about the year 1834, when Thomas Jackson started a small pottery at New Brighton. The panic of 1837, so disastrous to the business interests of the country caused suspension of business by Mr. Jackson.

Possibly the next venture was by the Hamilton Brothers, Lute and James, at West Bridgewater. The date when they began operations is not known to the writer, but Mr. Dicky, now 70 years of age, says that the Hamilton Brothers were making pottery in Bridgewater longer ago than he can remember. While he has no recollection of when they began, he feels certain that it was fully fifty years ago

*Second Geol. Surv. of Pa. Report, MM. p. 257.

that they ceased operations and removed to Greensboro, Greene county. (About 1857-8, see p. 25.) The Hamilton Brothers obtained their clay on the hill near Mr. Dicky's house on the west side of Brady's run, near its confluence with the Beaver river. They made common stoneware, the chief trade being in crocks and jugs. They would ship by boat to points along the Ohio and Mississippi rivers. The reason for their removal to Greensboro is not known.

Mr. Dicky states that to the best of his knowledge the first clay mined in the Beaver valley was used by the Mackenzie Bros. at Vanport, in a pottery at that place. No definite information could be obtained concerning the pottery industry at Vanport, except that it



Fig. 13. View showing face of clay, coal and overlying shale in clay mine at New Brighton, Pa. A—shale; B—Kittanning coal; C—Kittanning fire-clay 7 feet.

began at an early date and was continued by the Mackenzies and the Fowlers until quite recently, stopping only a few years ago.

Mr. A. F. Smith, of New Brighton, his son and his father, now deceased, have been closely connected with the clay industry in the Block House run region for many years. They were early settlers in this region, and realizing the possibilities in this great bed of potter's clay, they bought up much of the land in that region and for many years they have been mining clay and shipping it to different points in the United States and Canada, besides furnishing some of the home works.

The beginning of the present large pottery and kindred industries at New Brighton was in 1862, when Mr. Thomas Elverson, through the inducements offered by Mr. Smith, began making Rockingham and yellow ware in the little pottery on the hillside above the present site of the New Brighton pottery works. This little pottery, which is the mother of all the large works now in the valley, is owned by Mr. Smith, and has been idle for a number of years, but is now (1897) starting again on a small scale.

Mr. Elverson subsequently admitted Mr. H. A. Fisher as a partner, the firm being changed to Elverson & Fisher. Mr. Fisher later sold his interest to Mr. W. H. Elverson, son of Thomas Elverson, and the firm name was changed to Elverson & Son. In the year 1869 Mr. John Sherwood purchased an interest in the firm, the title of which was changed to T. Elverson, Son & Co., and the flower pot industry was added. Subsequently Mr. T. Elverson withdrew and the firm name was changed to Elverson and Sherwood, and thus continued until 1879, when Mr. C. A. Barker purchased an interest, when the title was again changed to Elverson, Sherwood & Co., and the large works now known as the New Brighton pottery was constructed, but they continued to operate the small works on the hill several years longer. In 1881 Mr. Louis H. Barker became a partner and the firm was changed to Elverson, Sherwood & Barker. In 1885 the firm organized under the limited partnership act and became Elverson, Sherwood & Barker, Limited, and so remained until 1890, when it merged into the Pittsburgh Clay Manufacturing Co., the company now operating the works.

In 1877 G. W. and W. D. Sherwood started a large pottery on Block House run, a short distance below the above, under the name of Sherwood Bros. Co. Both the above brothers are now deceased and for five years the business has been under the management of Mr. John Sherwood, still retaining the same firm name.

The Enterprise Pottery Co. was established, it is said, sixteen years ago, but has been under the management of the present company since December, 1893.

New Brighton Pottery Works.—The New Brighton pottery, as already stated, is the outgrowth of the small pottery started by Mr. Elverson in 1862. It is now owned and operated by the Pittsburgh Clay Manufacturing Co., who also own and control the sewer pipe works, the flue lining and flower pot works described elsewhere. The present officers are Mr. W. F. Lloyd, president; Mr. J. P. Sherwood, vice president; Mr. C. A. Barker, treasurer; T. D. Brown, secretary and superintendent of pipe works; Mr. W. H. Elverson, superintendent of potteries. They have nine kilns and a capacity of about 1,800,000 gallons per year, and employ a working force of about 125

men and boys. A side track from the Pittsburgh, Fort Wayne and Chicago Railroad runs to the works, and they are equipped for manufacturing and shipping all grades of stoneware and glazed ware. Their illustrated catalogue shows the following ware of many sizes: Butter pots, open jars, cream or Dutch pots, churns, jars and lids, water coolers, jugs, counter box, bottles, milk pans, bean pots, jelly cups, mugs, chambers, pitchers, cuspidors, fruit jars, chicken fountain, natural gas burners, and feed troughs.

They mine their own clay in part and purchase part of it from A. F. Smith & Son, using the native clay for the manufacture of all their ware. They use the Albany slip glaze and some New Jersey clay to mix with the native clay for the saggars.

Sherwood Brothers Co.—The works of the Sherwood Brothers Co. were started in 1878-79, by G. W. and W. D. Sherwood, who started with one kiln and one small building, but have enlarged their facilities from time to time until they are now well equipped in every way for manufacturing and shipping stoneware on a large scale. This company, now managed by John P. Sherwood, claims to be the most progressive one in the valley in getting out new inventions and making high grade ware. They originated the fine glazed milk pan and are the inventors of the glazed stew pan so well known throughout the country, the self-sealing fruit jar, that has had such a large sale, and shipping pail. They claim also to be the only firm in this country that makes the genuine light glazed Bristol ware, also the only company in this country that makes the stone screw-top jug for holding acids and other chemicals.

The fact that this was the only company from this region that had an exhibit at the World's Fair in 1893 is an indication of their progressive character. They now have eight kilns, two decorating kilns, and have a capacity of fifteen tons of clay per day, and employ a force of 125 men and boys.

They make the following, as shown in their illustrated catalogue: Jugs common bailed, mustard and screw top, ammonia jar, cremation jar, bottles of many sizes and shapes, beer mugs, jelly jars, packing jars, preserve jars, fruit jars, butter jars, snuff jars, cheese jar, beef extract jar, cosmetic jar, bean pot, shipping pail, coffee and tea pots plain and decorated, cuspidors plain and decorated, stew pans, milk pans, chair pans, mixing bowls, individual bakers, and water filters. Beside the above they make numerous fancy and decorated articles not shown in their catalogue.

The works are on a side track from the Pittsburgh, Fort Wayne and Chicago Railroad, and the wares are shipped in large quantities to all parts of this country. They have an extensive trade in New England, and other eastern markets. They obtain their clay from the Lower

Kittanning bed on the hillside at the works, and use a thickness of about six feet of the bed. Unlike many of the other clay works in the Beaver valley, this company owns its own clay land.

The Enterprise Pottery Co.—The Enterprise pottery is about 300 yards south of that of the Sherwood Bros. Co., on the side track from the Pittsburgh, Fort Wayne and Chicago Railroad, and the one nearest the mouth of Block House run. It was established about sixteen years ago and has been operated by the present company since December, 1893. They have three kilns and an annual capacity of about 800,000 gallons, with a working force of about 40 men and boys.

They make a variety of stoneware all of which is dark glazed on the inside. Their illustrated catalogue announces the following wares: Butter pots, tie jars, water jars, preserve jars, fruit jars, churns, bean pots, cream or Dutch pots, jugs, stew pans, milk pans, mixing bowl, jelly cups, pudding bowls, pipkins, shipping pails, bailed pails, chicken fountains, chambers, match holder, knife sharpener, mugs, cuspidors, water pitchers, water filters, greenhouse and window pots.

Their clay, which comes from the Lower Kittanning horizon, is mined by contract on the hill near the works. They pay so much per ton for it delivered on the dump.

The American Porcelain Co.—The works of the American Porcelain Co., are located on Block House run, at New Brighton, Pa. They began operations about three years ago and much of the time since then has been spent in experimenting. They at present appear to be in condition for doing a good business. They now claim to have a porcelain that will not craze or crack, moreover it is put on the green clay and all burnt at one firing, which is a saving over the biscuit burning method.

They now manufacture bathtubs, sinks, laundry tubs and refrigerator linings. They are pioneers in much of this work. The refrigerator lining they began last year and this year they say the output will be doubled. They all go to the Monroe Refrigerator Co., Lockland, O. The possibilities in this line are great, as the porcelain lining is certainly an improvement over the zinc in cleanliness, neatness and healthfulness. It needs but a glance at the interior of one of these porcelain lined refrigerators to show its desirability. The company makes three grades of these goods, one in which the porcelain is confined wholly to the interior of the vessel, another in which the porcelain extends out over a rounding rim, another which is porcelain inside and out. The last is the most expensive, the first the cheapest. The ware is made in plaster-of-Paris mold, partially dried in the molds, then air dried and burnt in saggars in kilns. Great care is

necessary in drying the large pieces and still greater care and skill are required in the burning and cooling or annealing operations.

The objections to bath tubs of this kind are their greater weight, which is from 500 to 700 pounds, and greater cost. These objections apply in a less degree to the sinks and laundry tubs. Yet they are so much neater and cleaner that for the better class of buildings they will be in demand despite their greater cost. The greater weight is not a serious objection as they are stationary objects.

The company states that their best markets are New York and Boston, where more expensive buildings are constructed. While they sell in Pittsburgh, Chicago, Cincinnati, St. Louis and elsewhere, the bulk of their trade is in the east as the more western cities demand a cheaper ware.

They have no rivals in this State and very few in this country. The company states that while there are three or four firms in the United States that manufacture a somewhat similar ware, with one exception the others make a cheaper grade of ware and hardly come into competition.

T. E. Marshall is the president and general manager; W. A. P. Graham, secretary and treasurer.

Sewer Pipe Works of the Pittsburgh Clay Manufacturing Company.—The sewer pipe works are about a mile above New Brighton on the east side of Block House Run on the side track from the P., F. W. & C. R. R. The works were started August 1, 1887, by the Pittsburgh Sewer Pipe Co., Limited, which changed its title in 1889 to the Pittsburgh Sewer Pipe and Fire Clay Co., and in 1890 consolidated with the Elverson, Sherwood and Barker Co. into the Pittsburgh Clay Manufacturing Co. Mr. T. D. Brown superintends the sewer pipe works.

The sewer pipes are made from the New Brighton or Lower Kittanning clay, the same bed that is worked at the potteries and not differing greatly in quality from that in the other mines. It is six to seven feet thick and overlain by twenty to twenty-two inches of coal. The company opened the Upper Kittanning clay but did not use it to any extent as it was too impure.

They also opened a bed of clay at a higher level, said to be twelve to fourteen feet thick, which they used during the period from 1889 to 1893 for making paving brick, of which they made a great many. In 1893 they ceased making paving brick, claiming that the price was too low for profit.

They mine their clay through shafts, the upper one in the valley being 45 feet deep. The strata dip southeast into the hill, thus necessitating pumping the water from the mines.

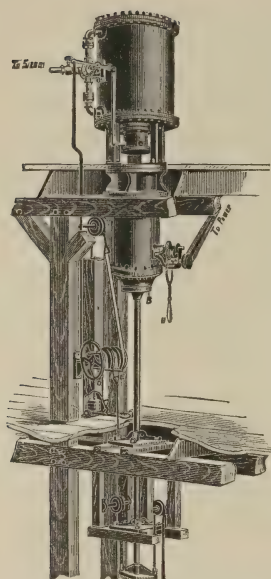


Fig. 14. Sewer pipe press.

The sewer pipes are made by machinery. (See fig. 14.) The clay is first finely ground in drypans and screened, then thoroughly mixed, and tempered and fed into the vertical clay cylinders, where the piston or plunger is slowly forced down on the clay, pressing it through the die at the bottom, where it is cut off in the desired lengths and then removed to the drying floor, where they are air-dried for six to ten days, which process requires considerable care to prevent cracking. They are burned in kilns from five to six days and allowed about the same time for cooling. Great care is necessary in the cooling or annealing process as a touch of cold air before they are cooled sufficiently will crack and thus spoil them. They are all salt glazed, which renders them impervious to water. They are all burned to a reddish-brown color.

The clay used for the sewer pipe differs but little from that used in the potteries and could be used for a light colored pipe, but Mr. Brown, the manager, says the market demands a brown pipe, and there is no sale for a light colored one, even though it might be equally good or better than the brown colored. The supposed reason for this whim is that the first pipe made in this country was brown; it was good; therefore only brown sewer pipe is good sewer pipe.

Pipes of 6-inch, 8-inch and 12-inch diameter are the more common sizes, but a great many other sizes are made and kept in their large stock. The storage yard covers an area of several acres. Their markets are mostly eastward to eastern Pennsylvania and the New England states, much of it going to Massachusetts.

The flue-lining factory is alongside of the sewer pipe works, immediately adjoining it on the east side, and belongs to the same company, viz: the Pittsburgh Clay Manufacturing Co. They manufacture flue linings, fire-clay pipe and fittings, bonnets, chimney tops of different styles, Mandary tops, wind guard tops and fire brick. They do not solicit fire brick orders, but handle the fire brick to fill small orders along with their other products. Their principal trade is in flue linings, for which they have fitted their works and which receives their chief attention and efforts.

The flue linings are made somewhat like the sewer pipe out of the same kind of clay. The clay is ground, screened, mixed and then fed into a machine similar to the sewer pipe press. The pieces are then

dried and burned, but are not salt glazed like the sewer pipe and are not colored, but have a light buff or cream color. They are made in sections about the same length as sewer pipe, and are of different shapes, but the most common form has a rectangular cross section with the corners rounded especially on the inside. These are placed one on top of another the desired height of the flue and a row of bricks built around them. They have the appearance from the outside of a common brick chimney, but give a larger inside space in proportion to the outside than the common flue. It is also smoother, the inside having fewer projections to catch the soot; it is at the same time safer, as there is less possibility of flames or sparks getting through them than through the common brick chimney. The company has a large sale for the flue linings and like the other works in the valley find their largest markets east. The economic advantages of these flue linings are so great that there will certainly be a large home market for them in the course of time as they become better known.

The Oak Hill Pottery, Pittsburgh Clay Manufacturing Co.—The Oak Hill Pottery is situated on the top of the hill overlooking Beaver river, opposite Beaver Falls and a mile and a half north of the village of New Brighton. The works were constructed and first operated by D. G. Schofield & Co., manufacturers of greenhouse flower pots and miners of fire-clay, a number of years ago, but the exact date of starting could not be ascertained. They failed about four years ago, and the works lay idle one year; one year they were in the hands of a receiver, and were then purchased by the Pittsburgh Clay Manufacturing Co. Mr. J. M. Lourimore is now manager of the works.

They make only red flower pots for greenhouses and window seats, and have a capacity of about 20,000 pots per day. Clay is obtained from the Lower Kittanning bed, on the east side of the works and mixed with a yellowish clay from the terrace deposit obtained at the northwest corner of the works. The latter, which is used in larger proportions than the light clay gives it the red color after burning.

The following analysis shows the chemical character of the clay:

Analysis of Terrace Clay at Oak Hill Pottery.

	Per cent.
Silica (SiO_2),	46.160
Alumina (Al_2O_3),	26.976
Iron oxide (Fe_2O_3),	7.214
Titanic acid (Ti O_2),	.740
Lime (CaO),	2.210
Magnesia (MgO),	1.520

	Per cent.
Alkalies,	3.246
Water,	11.220
Total,	99.286

The clay is thoroughly washed, screened and filtered through a hydraulic filter press. It is then tempered carefully in a pug mill, when it is ready for use. The pots are all joined in plaster-of-Paris mold, a much speedier process than the old method of turning by hand. The accompanying illustration (fig. 15) shows the process of jolly pots,



Fig. 15. View showing the method of jollying flower pots.

which is in no way different from the process in other potteries. One boy cuts the clay into lumps of the proper size and puts it into the mold, another puts the mold on the revolving plate, inserts the end of a jointed lever inside the mold. The centrifugal motion presses the clay firmly against the mold which shapes the outside of the pot, the lever or pull-down (see fig. 1) scrapes out the interior of the pot, the entire process being much shorter than the telling of it. A third boy takes the mold containing the pot to the drying shelves where after drying a certain time it is removed from the mold and further dried before putting it into the kiln to be burnt. One man with his two helpers will jolly about 4,000 pots per day.

With the exception of the small pottery on the South Side, Pittsburgh, described elsewhere, this is said to be the only flower pot works in western Pennsylvania. Their largest markets, however, are in the east, although they ship a great many pots to Indiana, Iowa and Virginia.

The works are situated on the terrace 100 feet above the railway and 125 feet above Beaver river. There is an inclined railway from the works to the P., F. W. & C. R. R., on which the ware is transferred and coal for the works brought up.

The Beaver Valley Pottery Co.—The Beaver Valley Pottery Co., Mr. Brewer, manager, operated a factory in the Block House run valley for several years, making yellow washboards. The works were said to be in operation about four years and have now (1897) been idle two years. They put a great many yellow washboards on the market during that time and experimented on glazed tiles, sinks, etc., but apparently not with much success, as the company failed and the works passed into other hands.

Mr. Brewer, the manager of the above company, has been experimenting in different lines, and now has some very handsome enameled tiles and brick which he says he can make successfully. He has recently patented a gurgless jug and has applied the same principle to bottles, glass jars and oil cans.

Messrs. Martin and Linton have leased the old "E. S. & B." pottery, the oldest pottery in the valley, that stands on the hillside above the New Brighton pottery. They expect to begin in a few days (September 1, 1897) to manufacture washboards and yellow ware.

The Mayer Pottery Co. (Limited), Beaver Falls, Pa.—The Mayer Pottery Co. makes plain white and decorated ware, such as dishes and table ware of all kinds. The works were established in 1880 and have been carried on prosperously since that time. They were entirely destroyed by fire last year, 1896, but were at once rebuilt and are again in successful operation. The works are managed by the two Mayer brothers, Joseph and Ernest, both able business men and skilled in the work. Their father was a skilled and progressive potter, constantly experimenting for improvements in his work, the results of which experiments he had kept in a very systematic manner. His son Mr. Ernest Mayer continued the same line of experimental work, but unfortunately the fire last year destroyed all the records of many years work. Mr. Mayer is taking up again this systematic study of clays, and it is hoped that the results of his experiments may be given to the scientific world when they cease to have a trade value to him.

They make semi-vitreous china, under-glaze printed ware, enamel decorated ware and colored glaze ware, all of which require a fine grade of clay, finer than the native clay.

The body of the ware they make is from kaolin from Delaware and Chester counties, Pennsylvania, Florida and North Carolina, and some of the plastic or ball clay is imported from England, but experiments now in progress are expected to confirm the fact that the imported clays can be nearly if not entirely dispensed with and clay from Jefferson county, Mo., used in its place. In the manufacture of white earthenware, the fact of the use of flint and feldspar is often entirely overlooked, and great stress laid on the clay item. Flint is used in the manufacture in larger proportion than any single item, and is usually mixed in the proportion of about 35 to 40 per cent. The flint they use is from Illinois and the feldspar from Pennsylvania. The body used by them is in round figures: flint, 35 per cent.; kaolin, 35 per cent.; plastic or ball clay, 16 per cent.; feldspar, 14 per cent.

They have five kilns and employ about 100 men, boys and girls, and turn out a great deal of fine table ware, which is shipped to all parts of the United States.

The Fallston Pottery Co.—The works of the Fallston Pottery Co. are situated on the east side of Brady's Run, about half a mile west of the village of Fallston. They are not in operation at present and nothing could be learned in regard to the time they were in operation. For some cause unknown the company failed and the works have been standing idle for several months at least. There is considerable ware in stock; light-colored stoneware similar in appearance to that manufactured in the potteries at New Brighton.

They used clay from the Lower Kittanning bed, the same as that used at the other potteries, and have also opened a bed at a lower horizon that appears to correspond with the Clarion bed. This bed is 12 to 14 feet thick and is apparently a good quality of potters' clay. How extensively it was used or with what success is not known, as none of the company or operators could be found.

Keystone Pottery Co.—Wm. Miller and sons, large lumber dealers at Rochester, formerly operated a pottery on the east side of Rochester. The pottery was in operation five and a half years, from 1890 to 1895. In June, 1895, the buildings were destroyed by fire and have not been rebuilt. The statement of the company is that the prices were then so low that it would not pay to rebuild the works.

There were three kilns and they made different kinds of stoneware like that made at New Brighton, having an especially large trade in ink bottles.

The works are situated on the banks of the Ohio river and close to the P., F. W. & C. R. R., thus having excellent shipping facilities both by rail and by water. Like the other potteries their principal trade was in the eastern states, Portland, Me., being one of the largest shipping points. They also shipped to Cincinnati, Chicago and as far west as California.

They used clay from the Lower Kittanning bed, the same geological bed as that used at New Brighton. The clay was mined from a drift in the bluff about 50 feet above the works. Some of the shale underlying the clay was used to mix with it in making the yellow ware.

No particulars further than those given in the historical sketch are available concerning the potteries said to have been operated at Vanport and Bridgewater many years ago.

The Beaver Falls Art Tile Co.—The Beaver Falls Art Tile Co. started their works at Beaver Falls in February, 1887, with J. M. May, chairman, and F. W. Walker, secretary and treasurer. The works are situated near the middle of the town of Beaver Falls, close to the P., F. W. & C. R. R.

They make decorative or glazed tile of great variety in sizes and colors. They carry a large stock on hand so that they can in most cases fill orders on their receipt.

They use clay from different points but the bulk of it, their estimate is 85 per cent. of the whole, is obtained from the clay mines at Block House run, New Brighton, in the New Brighton or Lower Kittanning beds, the same clay as that used in the New Brighton potteries. Where a white body is desired as in the white tiles, a purer kaolin is needed, which is obtained in part from Chester and Delaware counties, this State, and in part from Florida and North Carolina. The latter are said to burn whiter than the Pennsylvania kaolins. The clay is finely ground and screened through very fine screens, 200 meshes to the inch. It is thoroughly washed and passed through the hydraulic filter press in a manner similar to that in the potteries. Unlike the potters, however, they do not mix the clay wet to a plastic state but mould it dry. The nearly dry clay is put into the mould and stamped with a die forced down upon it by a screw. The tiles are first burnt in a biscuit kiln and then dipped into the proper glazing mixture to give them the color desired and then reburnt in the glazing kiln. Two biscuit kilns and three glazing kilns are in use. They make a great many different shades, which are all produced by various admixtures of the different metallic oxides. The mixing of these different colored glazes is an art requiring much experience and skill, and receipts for mixing them are carefully guarded. Mr. Walker, who has this part of the work in charge, has made a careful study of it, and has produced some very pleasing results. Like Mr. Mayer, he is a scientific experimenter, constantly working for new colors, new designs and new methods. His ingenuity and watchful care is shown in other ways, one of which is the unique single track, overhead, carrier system, used in transporting the ware from one point to another in the works.

The ware is all burnt in saggars, which are made largely out of New Brighton clay.

The company had a very handsome and instructive exhibit at the World's Fair, which with the other State exhibits is now at the State College. It contains a representative collection of the different colored tiles arranged in figures, and accompanied with the raw products and the different glazes before and after burning, showing the various stages of manufacture from the raw clay to the finished product. It attracts much attention in the collection and ranks among the most interesting exhibits of the State at the World's Fair in 1893.

CHAPTER IV.

FIRE-CLAYS AND FIRE-CLAY INDUSTRIES INCLUDING OTHER REFRACTORY MATERIALS.

The fire-clays and their industries reach first rank in Pennsylvania. The statistical returns for 1896 show that Pennsylvania produces not only more fire-brick than any of the other states, but almost as much as all of the others combined.

Value of the fire-brick product in the United States in 1896:*

Pennsylvania,	\$2,083,414
All other states,	2,823,509

Pennsylvania not only produces more fire-brick than any other state, but uses more than any other state, which is due partly to her great manufacturing interests, the huge furnaces, the hundreds of mills, and thousands of coke ovens demanding a constantly increasing supply of refractory materials. New Jersey ranks next to Pennsylvania in the value of its fire-brick products, which amounted to \$604,-988 in 1896.

Definition.—The term fire-clay is used with different significations by different persons. It properly signifies a clay that will stand the fire. But as any clay will stand a moderate degree of heat, and no clay is absolutely infusible, the limitation of the term fire-clay naturally becomes a question of the degree of heat the clay will stand without fusion. As most fire-clays are light colored, generally blue, it is customary in some places to call all blue clays fire-clays, and thus distinguish them from the common yellow or red brick clays. Nearly all fire-clays, whatever their color in the raw state, burn to a light nearly white color, hence with some persons any clay that burns white or nearly so, is called a fire-clay. In both cases the distinction is based on the relative amount and nature of the iron in the clay, a distinction which may frequently lead to error, as while iron is one

*Mineral Resources of the U. S., published by the U. S. Geol. Surv.

of the most common fluxes, there are others, such as the alkalies and alkaline earths which affect the fusibility as much as the iron, but do not change the color.

A blue clay might have a large percentage of iron in the ferrous condition and burn a bright red. It is possible on the other hand to burn a clay in such a manner that it may still remain light colored, but be none the less fusible. While it is true that many fire-clays are blue clays and most of them are light colored after burning, it does not always follow that all blue clays or all clays that burn light are fire-clays in the sense of being highly refractory clays.

One writer says* a fire-clay to be refractory should not contain over four per cent. of impurities. But this is rather misleading, as it depends on the character of the impurity and how it is diffused, as four per cent. of soda or potash would have more effect on the fusibility of the clay than double that amount of sand or titanite oxide.

The line might be drawn on the temperature at which the clay fuses, which would be the most accurate and logical distinction. The objection to such a distinction is that, owing to the difficulty in gauging high temperatures, it is not a ready or easy method of application, and such distinctions as those first mentioned, based on color, will continue to be used because of the ease of application. On the basis of temperature it will be necessary to set one or more arbitrary standards. If a low temperature is taken then it will be necessary to establish another to distinguish the high grade refractory clays from the low grade. One writer† says 2500 degrees Fahrenheit, but there is no commonly adopted standard as yet. When the working of the clays is put on a more scientific basis, and the methods of pyrometry are improved, all the fire-clays and other high grade clays will be tested and gauged on a fusion basis, and each clay labelled with its melting point. Arbitrary standards must be taken as there is frequently a wide range of temperature between the first evidence of fusion and the complete melting. The element of time also enters to some extent. These difficulties can be brought within practical limits so that it will be possible to designate a clay by its fusing points in a manner that will tell the intelligent manufacturer of the clay and the user of the product whether it will or will not suit his purpose.

As capital in the clay industries centralizes more, as it is doing in all lines of trade, the clays will be studied and classified more thoroughly and used in a more effective manner, as has been done in the iron industry. The iron master of 50 years ago would have smiled in derision at the care and precautions used at the large furnaces of the present day, yet a better and more uniform grade of iron is made

*Clay Industries of N. Y. Bulletin of State Museum, Vol. 3, No. 12, March, '95, p. 223.

†Wheeler-Missouri Geol. Surv., Vol. XI, clay deposits, page 133.

to-day in the large plants than was made in the small ones, and made with less cost and less waste.

There is no sharp distinction between fire-clay and potter's clay. While in general the potter's clay need not be so refractory as the fire-clay, it sometimes happens that both are taken from the same mine, as is done at New Brighton in western Pennsylvania, and other localities.

Varieties of fire-clay.—The different grades of fire-clay are divided into two quite distinct classes: (1) the flint or hard clays and (2) the plastic or soft clays. The flint clay differs from all other clays in its unique character, which is indicated by its name. It is quite hard and brittle, with a conchoidal fracture and looking not unlike flint in its apparent hardness* and fracture. One accustomed only to the soft common brick or potter's clay, would not suspect the clayey character of the flint, nor would he suspect it, should he attempt to work it like other clays, as it lacks that useful and characteristic property common to all other clays, namely plasticity. It does not slack like other clays when placed in water nor even when exposed to the weather. Weathering reduces it to a granular sandy mass, but devoid of plasticity. Nor is it rendered plastic by the ordinary grinding processes. It is claimed that prolonged and excessive grinding will induce a faint plasticity, but it is certainly not practical to render it sufficiently plastic to work alone, and it can only be used in the manufacture of ware of any kind by mixing it with a bond of plastic clay or other material.

Chemically the flint clays come nearer the kaolin base than almost any other clay. As they occur in nature they are purer kaolins than any of the so-called kaolin deposits, as all kaolins have to be washed before using to rid them of their impurities, while the flint clay goes direct from the mines to the grinding pan undergoing no separating process except that done by hand in the mining which is practically limited to picking out the ore balls. They are characterized by a higher percentage of alumina than other clays, in fact some of them have a higher percentage than the pure kaolin base, as may be seen by comparing the analyses in chapter IX. Sometimes they have a lower and sometimes a higher percentage of water than kaolin, and as already stated a lower percentage of fluxes or fusing material than any other of the natural clays. Hence they are used for fabricating the most refractory wares.

The flint clay rarely shows evidence of lamination, but its otherwise massive structure is broken by numerous vertical joints which separate the clay into irregular prismatic masses. This jointed struc-

*Its real hardness is less than calcite; that is, less than 3 in a scale in which flint is 7.

ture of the clay combined with its dark blue-gray color, hardness and compact texture, gives it a resemblance to the basaltic rocks which appearance is still further strengthened by the occasional concentric weathering so characteristic of the basalts and diabases.

The concentric weathering is most marked in the "ore balls" or the secretions of iron oxide in the clays as these nearly all show the concentric structure on weathering. It does not appear probable, however, that the iron causes the concentric character, as the same phenomenon occurs where there is but little or no iron. So that apparently the concentric structure antedates the deposit of the iron. In the accompanying illustration, Fig. 16, which is a view in one of the



Fig. 16. View in Mine, Bolivar, Pa., showing the concentric structure in the flint fire-clay.

Bolivar clay pits, there is very little iron, although elsewhere in the same vicinity the ore balls are numerous and nearly all show the concentric weathering.*

Flint clay varies in color from light gray to nearly black, and frequently has a brown surface stain of iron oxide. In most of the mines there is considerable iron oxide or iron carbonate, known among the

miners as ore balls. Near the surface they are nearly always iron oxide and in the interior of the bed they are commonly iron carbonate. The oxide balls are readily distinguished by their color and weight and the carbonate ones by their weight. It is necessary to pick out these ore balls by hand in the mining and working of the clay. Where the iron occurs in numerous small secretions, or in finely diffused condition, so that it cannot be removed by hand, the clay is useless for high grade refractory ware.

The mode of occurrence of the flint clays is in no wise different from the plastic, both occurring as sedimentary beds interstratified with the coal beds, sandstones and shales of the coal measures, sometimes immediately underlying the coal and sometimes separated from the coal by shale or sandstone. The beds vary in thickness from a few inches to 25 feet, sometimes all flint clay, but frequently associated with plastic clay. Where the two occur together, the plastic clay may lie underneath the hard clay or it may lie on top, sometimes both ways in the same mine. Sometimes the bed will be nearly all flint clay, sometimes nearly all plastic clay.

To those familiar with the flint clay mines in Pennsylvania, it would be interesting to know the mode of its occurrence in Missouri. It is there never formed in stratified beds or sheets that extend over large areas as in the case of plastic fire-clays and shales. They have an irregular, massive, jointed structure which seldom suggests a water-laid deposit. They always occur in limestone formations and occupy

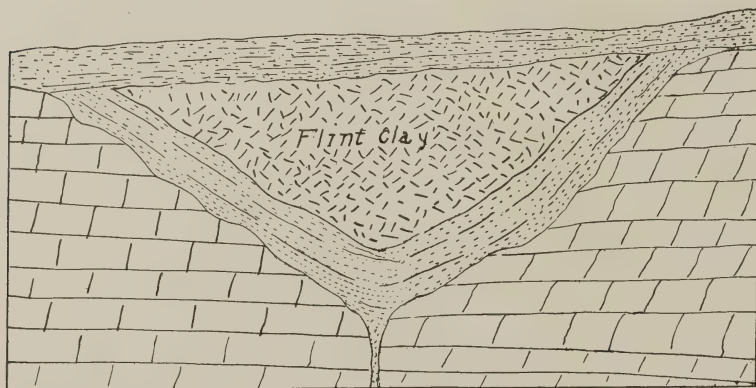


Fig. 17. Showing mode of occurrence of flint fire-clay in Missouri. The clay occurs in sink-holes in limestone, surrounded by sandstone.—*Mo. Geol. Surv., Vol. XI.*

local sink holes or crater-like depressions, which in size and shape are identical with the numerous sinkholes so characteristic of many of the Missouri limestone districts. The basins occupied by the flint clay vary from 50 to 200 feet in diameter and from 15 to 50 feet in

depth.† The accompanying illustration (Fig. 17) shows the mode of its occurrence.

Plastic clay.—The plastic fire-clays differ from the flint clays in that they become plastic when mixed with water. While never so hard as the true flint clays, they are frequently so hard as to require drilling and blasting to remove them economically from the bed, but on exposure to the weather they rapidly crumble into a soft plastic clay. It is found in most cases to be economical to mine the clay several months or a year before using it, as after exposure it is not only more plastic, but is much softer and can be ground and mixed much more economically.

As a rule the percentage of water in the plastic clay is lower than in the flint clay, the per cent. of fluxing ingredients (alkali, iron, lime and magnesia) is higher, and they fuse more readily. Where the most refractory brick is wanted the least possible quantity of plastic clay is used that will bond the other to the required strength.

Geological position of fire-clays.—In western Pennsylvania the workable flint clay deposits appear to be limited to the lower coal measures, or the Allegheny river series. Plastic clays and shales occur in the higher coal measures in both the lower barren measures and the upper productive or Monongahela series, but no deposits of flint clay were observed by the writer above the horizon of the Upper Freeport or E coal bed. Indeed very little plastic clay is worked from the higher coal measures, nor do such valuable beds occur there as in the lower series.

The most valuable bed of flint clay, the one worked most extensively in western Pennsylvania, is that near the top of the lower productive series, and known as the Bolivar or Upper Freeport clay, lying but a few feet below the Upper Freeport coal bed. At Bolivar it is 20 feet to 25 feet thick and varies greatly throughout the region. This bed is best developed along the west slope of the Chestnut ridge and in the Ligonier valley. Several other beds at lower horizons are locally valuable in many places.

The most valuable bed of plastic fire-clay is that immediately underlying the Lower Kittanning coal, and known as the Kittanning or New Brighton clay. (See p. —.) Many other beds occur at different horizons, and the plastic fire-clays are pretty well distributed throughout the coal measures. The thin bed which forms the clay parting in the Pittsburgh coal seam is utilized to some extent at two places in the Monongahela valley for the manufacture of refractory ware.

The origin of the carboniferous fire-clays appears to be linked with that of the coal beds. Their frequent almost universal occurrence immediately underlying the coal beds indicates that they formed the bottom of the swamp or bog in which the vegetation forming the

†Clay deposits by H. A. Wheeler Mo. Geol. Surv. Vol. XI, p. 202.

coal beds accumulated. The growth and decay of the plant remains extracted the iron and alkalies from this clay soil, leaving it freer from these bases than ordinary clay soils. In swamps at the present time we find in most cases a blue clay or black clay soil in marked contrast to the yellow clays of the dry areas.

It does not appear so clear why some clays should remain as soft plastic clay and that others should form the hard flint clays. The most plausible explanation that has been given for the flint clays is that the kaolin has crystallized wholly or in large part, and the flat crystal scales have no plasticity. The plastic clays are free from crystals and the minute particles of the clay are held together by the capillary water and yet not so firmly but that they can move rather freely around each other thus giving the clay its plastic property. Why some of it should crystallize and others not is probably due to a textural difference which has not yet been explained.

Possibly metamorphic action due to the uplifting and folding of the strata may have more to do with the change than is ordinarily supposed. Yet there are difficulties in the way of such a supposition. We find in the folded ridges of the mountains more flint clay in the same beds than in the region further west where the strata are less folded. Yet we find beds of soft clay in the mountains in the same hill with flint clay and sometimes in the same mine, and flint clay does occur in Ohio and other Mississippi valley states remote from the mountains. Pressure might change the physical properties of the clay making it less plastic but hardly alter its chemical character and make it more refractory.

A preliminary microscopic examination by the writer failed to show any marked difference microscopically between the flint and the plastic clay. By grinding a small quantity of flint clay in an agate mortar for some time I found it be quite plastic. The difference appears to be wholly one of induration. The minute particles in the flint clay are so firmly bound together that water will not separate them or penetrate the spaces between them as in the plastic clays. It may be questioned how much of the induration is due to pressure and how much to the chemical deposit; in all probability both agencies have been at work.

FIRE-CLAY PRODUCTS.

*Fire-brick.**—Probably more fire-clay goes into brick of different kinds than is used in any other way. The different kinds of fire brick, or those used for different purposes, require different grades of clay mixed in different proportions. Furnace bricks require a high grade

*Fire bricks were formerly limited in their use largely to lining furnaces and cupolas or to refractory purposes. Now they are used in vast quantities for building brick and paving brick. This use of fire-clay will be described elsewhere.

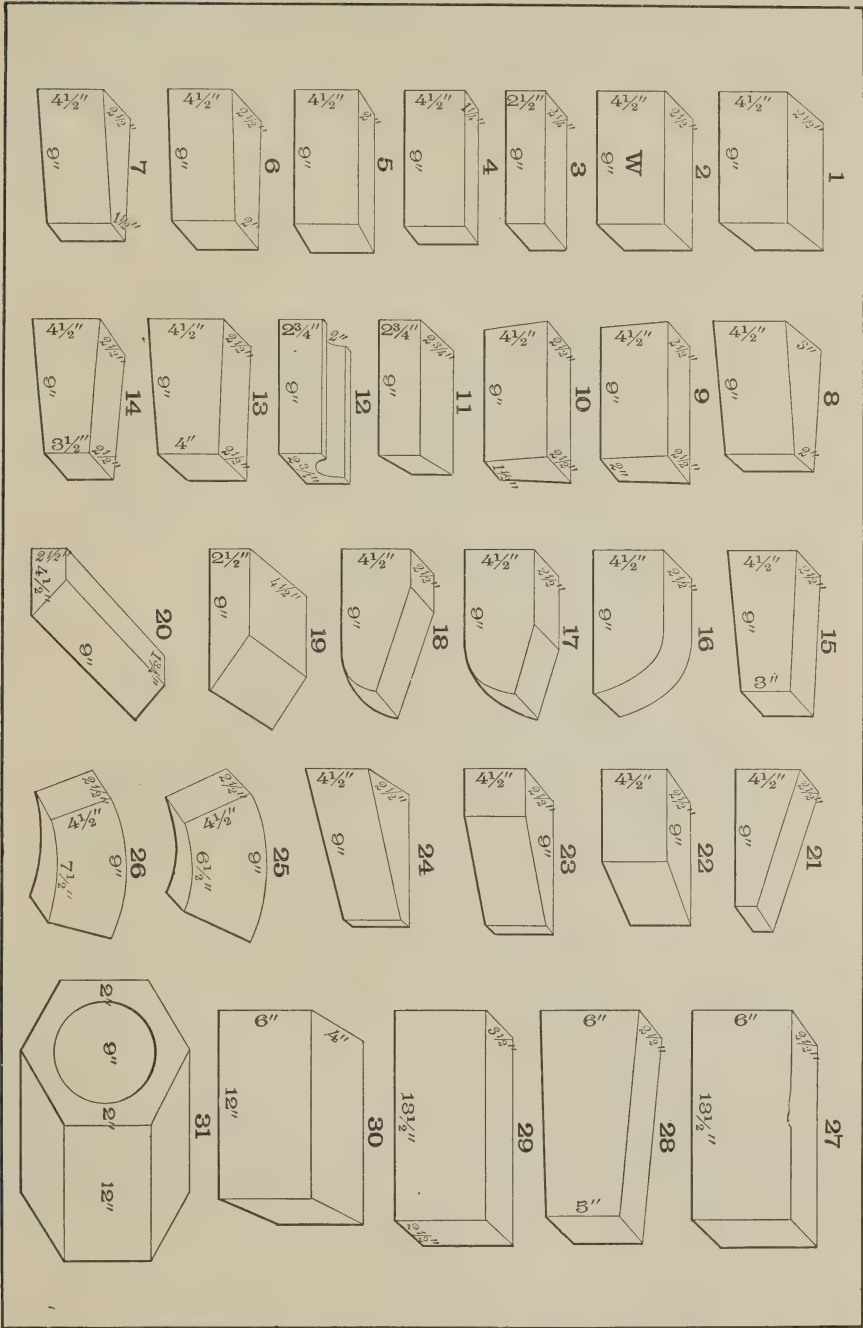


Fig. 18. Some of the common stock shapes of fire brick.

fire-clay but the upper part of the furnace, which is subject to much friction from the charge, requires a different kind of brick from the boshes where there is less friction but much greater heat. Hence the fire brick for the lower part of the furnace is made almost entirely of high grade flint clay using only sufficient plastic clay to hold the flint clay together, while the brick for the upper part contains a large percentage of plastic clay which gives added strength, the rule being that increasing the percentage of plastic clay increases the tensile strength and increasing the percentage of flint clay increases the refractoriness of the brick. The best furnaces use one or more intermediate grades through the middle of the kiln.

Mill brick and tile for use in the foundries, rolling mills and other mills require brick of different grades of refractoriness and abrasive strength. The varieties in (see Fig. 18) shapes, sizes and qualities of furnace and mill brick are truly surprising. This is best shown by giving a list of the standard shapes which are kept in stock by one of the large fire brick works of the district, which is as follows: Stock shapes of fire brick and tile 9 inch square; large 9 inch and small 9 inch; soap; No. 1 and 2 split; Nos. 1, 2 and 3 wedge; Nos. 1 and 2 arch; checker; key or wedge; Nos. 1, 2, 3 and 4 key; Nos. 1, 2 and 3 jamb; Nos. 1, 2 and 3 skew; Nos. 1, 2, 3 neck; 33 inch, 42 inch and 51 inch circle; 42 inch, 48 inch, 60 inch and 72 inch cupola; 13 and $\frac{1}{2}$ inch square; 13 and $\frac{1}{2}$ inch Nos. 2 and 4 key; 13 and $\frac{1}{2}$ inch square gas flue arch; 13 and $\frac{1}{2}$ inch arch 3, 4 and 5 feet in diameter; velvetry tile; stock hole tile; bridge block; Siemens furnace AA, A, B, C, 4, 5, 6 and 3; bevel cover, square cover and arch cover brick; regenerator blocks J, K, L, M and N; regenerator tile 9 sizes; flange or lap tile, 2 sizes; aft boiler tile, 3 sizes; centre boiler tile, 7 sizes; side boiler tile, 4 sizes; grate backs, 10 sizes; slabs, 5 sizes; furnace bottoms, 9 sizes; ladle nozzle, 5 sizes; stopper rod sleeve, 2 sizes and Bessemer tuyere, 4 sizes, making in all 127 different shapes or including the qualities 176 different shapes to be kept in stock.

As can well be imagined, coke oven bricks form a very important part of the trade in southwest Pennsylvania, which is the chief coke-producing region of the United States. The number of fire bricks required to build and keep in repair the thousands of bee hive coke ovens is very great. They do not require such a highly refractory brick as the blast furnace, but one that will stand sudden and violent changes of temperature, as the coke is commonly cooled by turning on a stream of cold water which comes in contact with the red hot bricks of the crown. Several companies make a specialty of coke oven brick and tile.

Locomotive and steamboat tile are made in considerable quantities, and besides supplying the local markets are shipped to distant markets, to the western part of the United States and to foreign countries.

Steel runners, sleeves and nozzles are comparatively new products now used in large quantities in the steel works for running the molten steel to the molds. They make a specialty of this work in the Monongahela valley in the clay from the Pittsburgh coal bed.

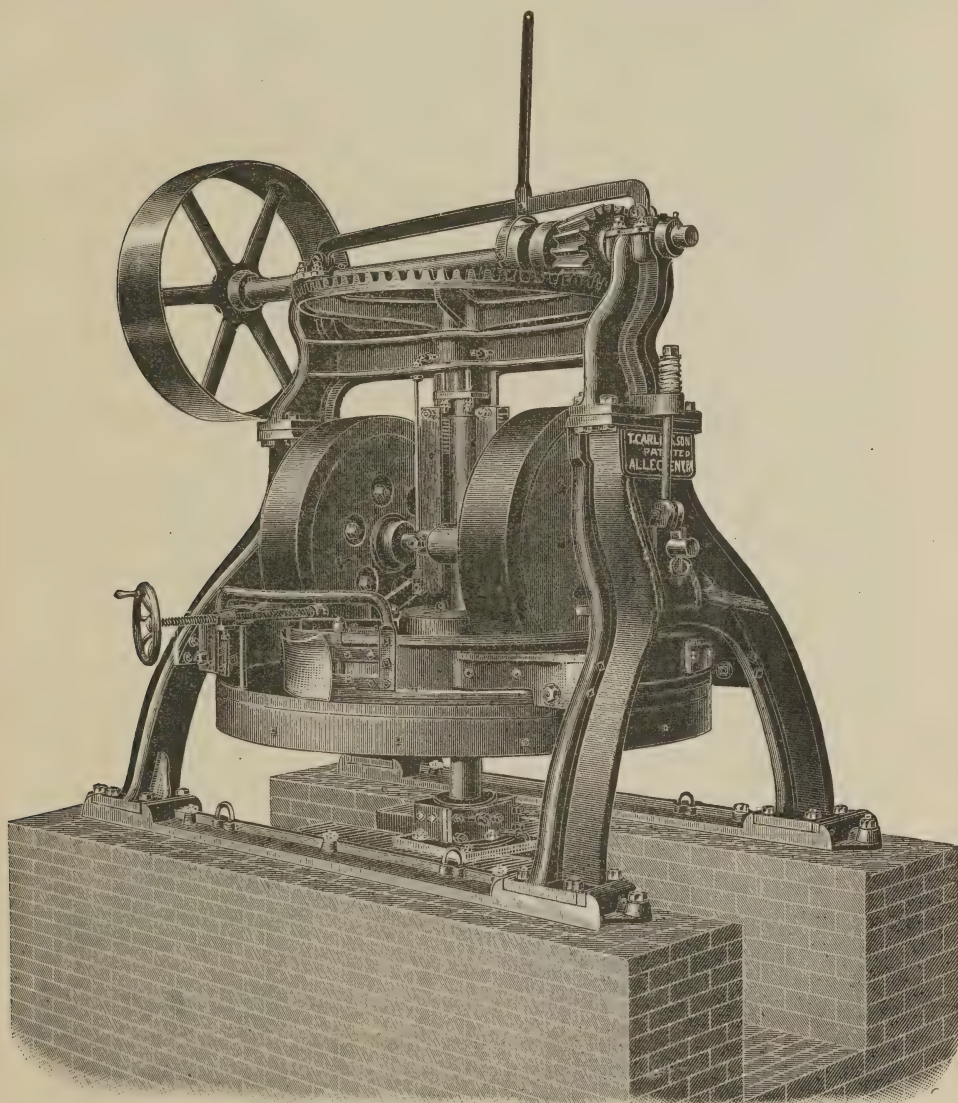


Fig. 19. Wet pan for grinding clay.

Methods of working the clay and machinery used.—There are two methods of removing the clay from the earth; one by stripping the overburden and quarrying from the surface, and one by running in a drift and mining underground. Which of these methods is employed depends on the thickness and character of the strippings, the thick-

ness of the clay and its position in the hill. Sometimes both methods are used together, that is, the clay is worked by stripping at the out-crop back in the hill until the overburden becomes too heavy to remove with profit, when a drift or mine is run in from the face and the process continued under ground.

The mining or quarrying is in nearly all cases done by blasting, in which the blasting auger similar to that used in coal mining is used, where the clay is soft enough to permit its use. After blasting, the clay is loaded on the mine cars and run to the works or to the railway.

For common fire brick where the molding is done by hand, the clay is ordinarily ground and mixed in the wet pan, a heavy revolving iron pan with two very heavy iron rollers revolving inside.

For the flint clays these are made very heavy. (See Fig. 19.) The clays in the proper proportion are dumped into the pan, sufficient water run in for the mix and the machinery set in motion until it is thought to be ground sufficiently, when it is removed to the molding table and another batch put in. There are numerous sizes and styles of the wet pans, but all operate on the same principle. Some are emptied automatically and some by hand.

Where the bricks are molded by machinery, it is necessary to remove all the coarse lumps and have a more uniform consistency than is obtained by the above process. Then the clay is ground in a dry pan and screened. The dry pan resembles in many respects the wet pan, but there is no water put in the pan with the clay and the bottom of the pan is perforated to permit the ground material to filter through. (See Fig. 20.) Rolls and disintegrating machines are sometimes used in place of the dry pan and sometimes in conjunction with it. These are sometimes simple smooth rolls, sometimes conical rolls, sometimes corrugated rolls, and sometimes combinations of rolls with cutters, or even the ordinary rock crusher.

After grinding the clay is elevated, generally by a bucket elevator, and screened, the fineness of the screen depending largely on the kind of ware to be manufactured. The tailings run back to the dry pan or rolls to be reground. The screened clay is run into storage bins from which it can be fed into the pug mill.

Tempering and molding.—Where the clay is ground dry it is tempered or mixed to the right consistency with water, either in a wet pan or a pug mill. The pug mills are of different types, some vertical, and some horizontal, some combined with the molding machine and some separate. See under building bricks, chapter VI.

Most of the manufacturers are emphatic in their statement that good fire brick must be molded by hand and not by machine. The objection to the machine-made fire brick is two-fold: first, that it is too dense, and hence will not yield so readily to extremes of temperature as a more open textured brick; second, the brick is not homogene-

eous throughout, as the clay is more or less laminated as it is pushed through the die. Both these objections, however, are more applicable to the stiff-mud machines than to the soft-mud machines. So firm is this belief among manufacturers and evidently therefore among the users that most of the oldest and best known dealers manufacture fire brick only by hand even when machines for making building brick are standing idle in the works.

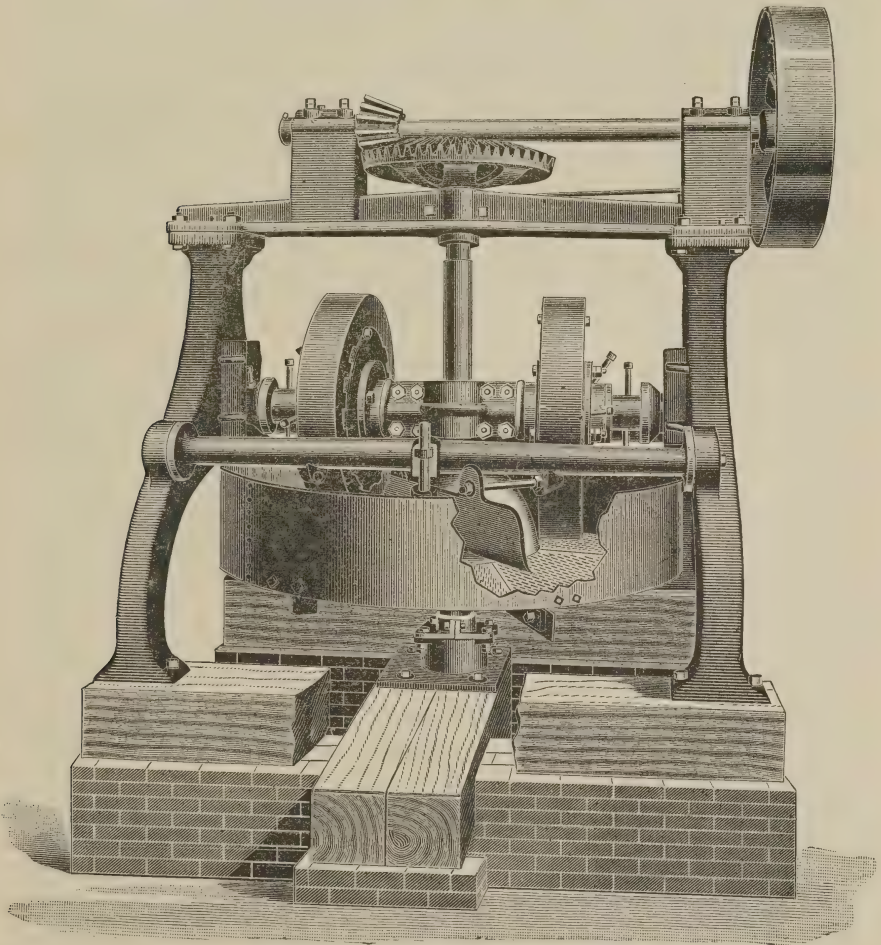


Fig. 20. Dry pan for grinding clay.

Drying, pressing and burning.—Where the bricks are molded by hand, they are dried on a drying floor. The molding tables are placed at the edge of the drying floor and the off-bearers take the bricks from the molder's hands, place them on the drying floor and sand and return the molds. The bricks after drying about half a day are pressed in the repressing machine (see Fig. 22), and returned to the drying floor or sent to the drying kilns. The significance of the term repress is

not clear. The reason for the pressing is that the bricks when molded are too soft to retain their form, shape or brands. After a half day's drying they are stiff enough to retain the smooth surface, sharp edges and clear branding of the press. This is commonly done by hand, as it is claimed that the hand press makes a more uniform brick than the steam press. A press crew will handle the same number, 4,000 bricks, as a molding crew. The molding is commonly finished about noon, and the press crew follow, pressing in the afternoon the bricks that were molded in the forenoon. In some places the molding is done in the afternoon and pressed the next morning. The burning is sometimes done in a down-draft, sometimes in an up-draft kiln; they are sometimes burnt hard and sometimes soft. The same care is not necessary in burning fire brick as in many other kinds of ware. If the clay is good and the brick properly molded, it is a good brick whether it be burnt hard or soft. Two companies burn part of their brick in the continuous multiple-chambered kilns. Of the others some prefer the down-draft, and some the up-draft kiln. For description of these see under building brick.

Gas retorts require a high-grade clay, one that will make a strong elastic and highly refractory product, and one that will withstand the chemical action of the vapors and gases from the coal. There is but one firm in western Pennsylvania manufacturing gas retorts at present, and that is Jas. Gardner, Jr., at Lockport, Pa. Retorts were made formerly at other points, but the use of iron retorts and other methods of gas manufacture have diminished the use of clay retorts.

Glass pots or the large pots in which the glass batch is melted, require one of the highest grades of fire-clay, one that requires greater care in selection and preparation than any of the other wares mentioned.

The pot must not only stand the high temperature of the melted glass and the glass furnace, but must also withstand the chemical action of the fluxes, such as soda cake and lead oxide used in the mix, which are much stronger corroding agents than the fluxes of the blast furnace.

The clay is subject to very careful inspection both at the mine and at the factory; every lump is broken up by hand into small fragments and every impurity thrown out. This work is frequently done by women. The same care is taken with the old pots which are broken to pieces and every fragment of slag or impurity carefully chipped off.

As in the lining of a blast furnace, different grades of clay are used in different parts of the pot. Thus the top of the pot has only to withstand the heat and bear its weight while the sides are subject to the weight of the top, the pressure of the liquid and the corroding action of the salt-cake.

The clay is prepared much as in fire brick manufacture, except

greater care is used in all the processes, and it is put through an extra process called "sweating," in which the moist clay when mixed for use is covered with blankets and allowed to sweat for several months or a year if possible. It is claimed that this has great influence in the working quality of the clay. By some operators the clay is mixed by tramping it with the bare feet, which it is claimed is far superior to any known mechanical process.

The making of the pot is a slow process, taking weeks, and including the drying, even months. It is thus necessary to keep a considerable stock of pots on hand in order to fill orders with any degree of promptness. The pots are not burnt until they are put in the furnace where they are to be used, and then it is the aim to keep them hot until they are burnt out, generally an interval of several months, as they are liable to crack in cooling.

The pots are all numbered and a record kept of them; when they are burnt out they are sent back to the factory and are used as material in building others. As the larger pots weigh from 3,000 to 4,000 lbs., each, the material is quite an item and the utilization of the old pots quite a saving. Single pots cost from \$50 to \$60 each.

There are but two factories in western Pennsylvania that manufacture glass pots for the trade. The Pittsburgh Clay Pot Co., on Rebecca street, in Allegheny, and the Phoenix Clay Pot Works, Brush-ton avenue, Pittsburgh, but many of the large glass companies manufacture their own pots at the glass works, and it forms a very important feature of the industry.

Clay for glass pots is mined at Wymp's Gap and Layton Station, Fayette county and in Cambria, Clarion and Clearfield counties, but a considerable part of the clay used for glass pots in Pennsylvania is imported from Missouri, Kentucky, Germany and England.

It is not only possible but probable that there is abundance of good glass pot clay in Pennsylvania which would be used if its presence and properties were fully known to the pot-makers. But the glass pot is such a large and expensive affair that few manufacturers care to experiment on untried clays, and when they have a clay which answers their purposes they continue to use it even though expensive, thinking it is cheaper than experimenting with untried clays. Equally good clays may have quite different properties requiring different treatment, which generally can be gained only by experience, hence the reluctance of operators to try new clays.

Success in making and using glass pots depends on the following conditions:

1. In having a first class high grade refractory clay.
2. Proper preparation and mixture of the raw and burnt clay. An average is about 8 parts of burnt clay to 7 parts raw clay.
3. Proper handling by the pot-maker.

4. Manner of drying and annealing.

5. The temperature of the furnace, the kind of glass to be melted and the treatment of the pot by the smelter.

Much glass is melted now in large tanks made of iron and lined with blocks of fire-clay.

Crucibles.—Large quantities of fire-clay of different grades are used in the manufacture of crucibles of different kinds. The necessary qualities in crucibles are: 1. They should resist high temperatures without melting or softening in a sensible degree, and should not be so tender while hot as to crumble when grasped by the tongs. 2. In some cases they should resist sudden and great changes of temperature. 3. They should be able in some cases to resist violent corrosive action and permeation of molten metals.

The clay for crucibles must be selected with reference to the use to which the crucible is to be put, and must be ground and mixed with care. As with glass pots, which are only large crucibles, considerable quantities of burnt clay or silica must be mixed with the raw clay to neutralize the shrinkage.

Crucibles are used in the burnt and unburnt condition. Small crucibles are nearly always kiln burnt before they are used. Large crucibles like glass pots or casting pots are not burnt except in usage.

So far as known to the writer, no crucibles except glass pots are manufactured in western Pennsylvania. Many of the crucibles used in the United States are imported from England, France and Germany.

Crucibles are also made of graphite, of clay and graphite, of clay, coke and graphite, of alumina, lime and magnesia.

Stove linings and backs for fire places consume large quantities of medium grade fire-clay.

Besides the refractory uses, fire-clay is used in large quantity as a base or body for paving brick, vitrified building brick, several grades of pottery and hollow ware, and other varieties of ware.

OTHER REFRACTORY MATERIALS AND PRODUCTS.

The use of brick made from fire-clay is partially replaced in certain lines of furnace work by what are known as basic brick and silica brick. The ordinary fire-clay is a nearly neutral substance, but it has been found from experiment that a purely basic substance, or a purely acid one is even more refractory under proper conditions than the neutral substance.

The basic brick are used in the basic process of steel manufacture and are made of magnesia obtained by calcining magnesite. As magnesia is much more expensive than the fire-clay, the magnesia brick are used in comparatively small quantities and only for their basic property, as the magnesia has the power of taking up and fixing the

phosphorus to some extent, and steel can be made by this process from iron higher in phosphorus than could be used in a furnace with a neutral or acid lining. Dolomite or the double carbonate of lime and magnesia is used for the same purpose. Evidently the basic lining is limited in its use to processes with a basic slag, as in the presence of acid it quickly fuses.

All of the magnesite used in the eastern and southern states is imported. The only magnesite now quarried in this country is in California and the freight rates are so high that it is cheaper to import the material from Greece and Austria for use in the eastern and southern states than to ship from California, so the western product is used on the western coast.* Magnesite was at one time quarried in eastern Pennsylvania.

Silica brick.—Silica brick have long been used in glass furnaces and in the steel furnaces where steel is made by the acid process. Like the basic brick the first ones used in this country were imported, but now large quantities of silica and sand brick are made in western Pennsylvania. A number of the fire brick manufacturers make silica brick along with common fire brick and a few companies make silica brick alone.

The first silica brick were made by mixing the ground silica with a plastic clay which served as a bond. The silica expands on heating and the clay contracts, hence the bond would be much shattered and the bricks be soft and friable. This method is still used to some extent for certain grades of brick and the product generally called "sand brick." Lime is found to make a stronger bond and is the one commonly used for the "silica brick," as it overcomes in part the defect from shrinkage found in the plastic clay bond. They are molded by hand for the most part, but some are made in the soft-mud machine.

Probably the first silica brick made were the famed Dinas brick (named from Dinas rock in the vale of Neath), manufactured in England in 1822. The refractory power of the material called Dinas clay was known many years before that date and it was used for furnace hearths and linings, but for many years no successful method could be found of manufacturing it into brick. The process of manufacturing the brick was kept a rigid secret for many years, and even at the present time many of the manufacturers assume an air of great secrecy about the method of manufacture.

A material very similar to the "Dinas clay," that is used extensively

*On the uses, occurrence, and manufacture of magnesia brick, see *The Mineral Industry*, N. Y., Vol. II, 1893, and on the manufacture of steel by the basic process the same publication Vol. V, 1896. For analyses, specific gravity and comparative tests on the expansion of American and Grecian magnesite and coke oven tiling, see *Mineral Resources of the U. S.*, 1896, or *Trans. Am. Inst. Min. Eng.*, Sept., '96.

at Sheffield, is there called ganister. It is supposed to occur at the same geological horizon as the Dinas clay, the millstone grit of the lower coal measures.* The term ganister has come into quite general usage for the siliceous material suitable for silica brick or furnace lining. It is now found and utilized in many localities.

Much of the silica used in western Pennsylvania is Medina sandstone of Silurian age, shipped from Huntingdon and Blair counties. Some local rocks are used at Layton, Bolivar, Black Lick and up the Allegheny river, all of which are sandstones of the coal measures. The following companies manufacture silica brick only: (1) The Wm. Stuart Silica Brick Co., Kingston. (2) The Stuart Fire Brick Co., Layton. (3) Silica Brick Co., Layton (not now in operation). (4) Phoenix Fire Brick Works, Manorville.

The following companies manufacture silica brick along with other fire brick: (1) Reese, Hammond & Co., Bolivar. (2) A. J. Haws & Son, Johnstown. (3) The Burl Fire Brick Co., Black Lick. (4) Harbison & Walker, Pittsburgh. (5) S. Barnes & Co., New Brighton.

In some localities silica rocks are found of such a nature that they can be dressed to the desired shape and used in the furnace without the necessity of first making them into brick. They may be used for furnace hearths or entire furnace linings and are known as firestones. There is a large quarry of such rock at the base of Chestnut Ridge on the National road, about three miles east of Unionville.

Carbon, lime, talc, asbestos and bauxite are other refractory substances, but used in small quantities compared with fire-clay and are hardly competitors in the market with fire-clay. Carbon in the form of graphite or coke is very refractory and used for making crucibles and furnace brick. Some are made of carbon alone and some of carbon and clay mixed. Both kinds are made by Harbison & Walker, Pittsburgh, Pa. Lime is one of the most refractory substances in nature but it is not adapted to many refractory uses on account of its strong affinity for moisture and acids. It is used to some extent for small crucibles and in the oxyhydrogen or lime light. It is used as a bond in the silica brick, not however on account of its refractory power but because it fluxes with the silica, thus binding the grains together.

Alumina is very highly refractory and is used to some extent for manufacturing refractory material. It is more commonly used in the form of the mineral bauxite. Most of the bauxite mined in the United States is obtained in Georgia. Large quantities of it occur in Arkansas near Little Rock, but little commercial use has been made of it as yet.†

*Percy's Metallurgy, Fuels, Etc., p. 146.

†Arkansas bauxite, *Journal of Geology*, Vol. V, p. 290, 1897; Georgia bauxites, *Bull. No. 2, Geol. Surv. of Georgia and Trans. Am. Inst. of Min. Eng.*, Vol. 24, p. 234.

CHAPTER V.

THE FIRE-CLAYS AND FIRE-CLAY INDUSTRIES IN WESTERN PENNSYLVANIA.

THE OHIO VALLEY.

There are a number of factories in and near the Beaver valley that make fire brick as a side issue along with their other products; such are the sewer pipe works at New Brighton, the Fallston Fire Brick Co., The Park Fire Clay Co., all of which are described elsewhere under their appropriate headings. (See under potteries, building brick, paving brick.) There are, however, other companies that make fire brick as their chief business; such are described below.

The clays in the Beaver valley region are described under pottery in Chapter III. The same bed of clay, the Lower Kittanning, that supplies the potteries is the one that supplies the fire brick works, the latter being able in some instances at least to work a greater thickness of the clay than the potteries by using more of the sandy material at the base. For the most highly refractory bricks flint clay is shipped in from other points, mostly from Clarion, Clearfield and Cambria counties.

S. Barnes & Co. (Limited).—The fire brick works of S. Barnes & Co., located on the east side of Beaver river, about a mile above Rochester, is one of the oldest in the State or in the country. Mr. Douglass, the superintendent of the works, has been here for 37 years, and says that he can remember that Mr. Barnes was making fire brick here as early as 1839, which would make the works nearly 60 years old.

This company manufactures fire brick and refractory materials of all kinds. The chief trade and the trade which they seek is that in high grade refractory fire brick for furnaces. Several grades of brick are necessary in a furnace lining: the upper part of the furnace should be lined with a strong brick that will resist abrasion, such a brick as can be made from the clay mined at the works. The lower part of the furnace should be lined with highly refractory material, more refractory than the Beaver valley clay, and which is obtained by shipping in flint clay from other points. Most of that now used is obtained from Clarion county, but some of it has been obtained from Jefferson and Clearfield counties. The flint clays while highly refractory are non-plastic and enough of the plastic native clay is used to form a bond. Between the top and bottom parts of the furnace intermediate grades are used, increasing the proportion of plastic clay as greater abrasive strength is desired, increasing the

proportion of flint clay as greater refractoriness is desired. The company carries a large stock of furnace brick on hand and the men in charge have made a study of the needs of the trade in this line, which combined with their long experience give them proficiency in supplying the furnace trade. They also have considerable trade in hot blast stove linings, which they ship to many different points.

They ship large quantities of fire brick to Chicago, some of which is reshipped from there to Minnesota, and other western states.

The bricks are all made by hand and dried on a drying floor. They are burnt with coal in square up-draft kilns.

Ingram & Co.—The fire brick works of Ingram & Co. are situated on the east side of the Pittsburgh, Fort Wayne and Chicago Railroad, between Rochester and New Brighton. They manufacture fire brick only.

They use the Lower Kittanning or New Brighton clay, which is mined at the works. It is ground in a dry pan, elevated, and screened, then mixed in a pug mill and moulded by hand. The works have a normal capacity of 8,000 per day, which are burnt in three kilns, one square kiln holding 50,000, and two round kilns holding 65,000 each.

Their chief market is Pittsburgh and their shipments are made over the Pittsburgh, Fort Wayne and Chicago Railroad.

A. F. Smith & Co.—A. F. Smith & Son own two brick yards at New Brighton, one of which is now (August, '97) in process of construction, and the other is idle. Mr. A. F. Smith's father constructed the latter works about 1845, on the hillside southeast of New Brighton on the southeast side of Block House run. Both building and fire brick were manufactured.

The fire brick works now under construction by Smith & Son are on the northwest side of Block House run, at the entrance to one of their fire-clay mines, about a quarter of a mile below the sewer pipe works. As already stated (Chapter III) Smith & Son ship large quantities of raw fire-clay, both ground and unground, to various points in this country and Canada.

G. Dando & Bro.—The Conway mine, at Conway station, near Freedom, on the Pittsburgh, Fort Wayne and Chicago Railroad has been operated by G. Dando & Bro. for two years. It was formerly operated by Mr. Dunbar and known as the Dunbar mine. They ship ground fire-clay only, none of which is manufactured at the mine. The clay is mined from the same geological bed as that at New Brighton, namely, the New Brighton or Lower Kittanning clay. The bed at Conway station is six to eight feet in thickness and overlain by two feet of coal, which is mined with the clay. The clay lies below the bottom of the valley at this point and both the clay and coal are drawn from the mine up an incline by a stationary engine. The clay

is then ground, screened, and shipped as ground clay, most of it going to Pittsburgh.

The clay and coal are both exposed in the cuts along the wagon road a short distance east of the mines.

Welch, Gloninger & Co., Monaca, Pa.—The works of Welch, Gloninger & Co., at Monaca, are on the south side of the Pittsburgh and Lake Erie Railroad, about half a mile below (west of) the Monaca depot. They have been in operation for sixteen years and have built up a large and profitable trade. They have a daily capacity of 20,000.

Their principal trade is in furnace and mill brick, which they ship to the big iron works in Pittsburgh, Cincinnati, Chicago, Cleveland and elsewhere. They are at present (August 31, 1897) filling a large order to Cleveland. Building brick and paving brick are made as a side issue. Their building brick are made in many colors, buff, brown, gray and mottled, and are shipped to many points in the eastern and central states.

They use both the soft-mud and the stiff-mud wire-cut machines. The bricks are dried in a drying tunnel on the cars and transferred to the kiln without extra handling. They use the Osmond and Basset continuous circle kiln, containing sixteen chambers. Nearly all their brick, fire, building and paving are burnt in this kiln.

The clay used is that underlying the Lower Kittanning coal, the same bed as that used at New Brighton. The opening to the mine is on the roadside, on the river bluff, about 30 feet above the mean level of the river. The clay is pushed in cars to the mouth of the mine by hand and is pulled from there by steam power up an incline to the works. They mine about six feet of the clay, leaving the more sandy part at the base. The coal overlying the clay, two feet in thickness, is mined with the clay. Overlying the coal bed there is a thickness of about fifteen feet of shale, two feet of impure fire-clay, four feet of hard, dark shale, two to three feet of soft shale and clay and four inches of coal.

The Stahl Fire Brick Co., Beaver, Pennsylvania.—The works now owned by the Stahl Fire Brick Co. are situated on the south side of the Ohio river, opposite Beaver, and a mile or more below Monaca. Fire brick works are said to have been started here about fifty years ago. Mr. Noss is thought to have been the founder, at least one of the early proprietors. The Pendleton Brothers operated the works for many years, but for ten or twelve years the Stahl Fire Brick Co., of Beaver, has been in possession. The works have not been in operation for three years, but they are now (August, 1897) putting them in repair, expecting to start the manufacture of fire brick at once.

They make a specialty of furnace brick and shapes of many kinds and produce hand-made bricks. The clay is ground in a dry pan,

elevated and screened, then mixed in a pug mill, molded by hand and dried on a dry floor, and burnt in an up-draft kiln.

The clay used is the Lower Kittanning or New Brighton fire-clay, and is mined in the hill at the works. The products are mostly shipped by boat on the Ohio river. To ship by rail it is necessary to haul to Monaca.

The company claims to have a heavier bed of clay near the top of the hill and another underneath the Kittanning bed, neither of which has been used.

They experimented for a number of years on porcelain enameled brick, but were not successful and they now confine their attention to fire brick only.

About one mile below Monaca, between the works of the Stahl Fire Brick Co. and Monaca, there is an abandoned fire brick works that is said to belong to L. S. McKallip, of Pittsburgh. The works were started it is said about 35 years ago by French & Quay, French being the active and Quay the silent partner. The business did not succeed as well as expected and French sold out to Mr. McNees, and Quay sold out to Dr. McKinney. Later the Stuart Brothers and Mr. Troop obtained possession. The Stuarts soon sold out to McKallip, who later bought out Troop. After a few years McKallip ceased operations and although he still owns the property the works have been idle it is said about six years, and as might be expected, are sadly out of repair. They made fire brick from the New Brighton or Lower Kittanning bed of clay, that was mined at the works and experimented extensively with enameled brick, even, inducing, it is said, several experienced parties to come from Scotland, but apparently they were not successful in that line.

Welch, Gloninger & Co., Vanport, Pa.—The clay works of Welch, Gloninger & Co., at Vanport, are situated in the narrow space between the Cleveland and Pittsburgh railroad and the river hill, about half a mile below the village of Vanport. They have three rectangular down-draft kilns, each holding about 65,000 brick. They use both the soft-mud and the stiff-mud machines, but most of the brick are made on the stiff-mud wire-cut machines.

The chief trade is in fire brick, but buff, gray, brown and mottled building brick are made. The building brick are re-pressed in the steam power re-press machine.

The clay used is the Lower Kittanning or New Brighton clay, the same as that used in the Beaver Valley. It varies from six to nine feet in thickness, but in most places is about six or seven feet thick. The bed is characterized by numerous "slickenside" seams running in different directions. This feature is more pronounced in this mine than in any of the others observed by the writer in western Pennsyl-

vania. The shale overlying the clay makes an excellent roof, and they have had no trouble from crumbling of the roof, although the mine has been worked for many years, and some of the gangways are two or three times as wide as the average.

The Vanport Brick Co., Vanport, Pa.—The works of the Vanport Brick Co. are said to have been established by Mr. S. R. Mitchell more than 30 years ago. Mr. John Russell, it is said, was the next proprietor and the Vanport Fire Clay Co. had control until the latter part of 1897. Because of financial difficulties the works were idle for two months or more in the summer of 1897. The works are now operated by the Vanport Brick Co.

They use the stiff-mud wire-cut machines with both the steam and hand re-press machines. The daily capacity is about 20,000, the bricks are dried in a steam drying room and burnt in round down-draft kilns, of which they have five.

Probably their largest trade is in building brick, yet they make many fire bricks and some paving bricks.

The clay used comes from the Lower Kittanning bed which is said to be 11 to 12 feet thick. The mouth of the drift at the head of the incline above the works shows a thickness of about 10 feet of clay overlain by 20 inches of sulphurous coal overlain in turn by a soft, yellow brown shale. The clay is underlain by a bed of thin flaggy to shaly sandstone grading into shale. Occasionally some terrace clay is used to give the bricks a darker color.

Mahan postoffice, Park Fire Clay Co.—Near Mahan postoffice, a few hundred yards below the Vanport dam in the Ohio river, is a small fire brick works said to have been purchased recently by the Park Fire Clay Co., of Rochester. It was not in operation at the time of my visit (September 3, 1897), nor was there any one in the vicinity who could give any information concerning it.

There are three small rectangular kilns. The bricks on hand are nearly all light-colored almost white fire bricks, there being a few rough building bricks.

The clay obtained at the works is from the Lower Kittanning bed, the same as that worked at Vanport and in the Beaver valley. The clay at the mouth of the mine is 10 to 12 feet thick overlain by 2 feet of bituminous coal, and closely resembles in appearance that found up the valley.

PITTSBURGH.

A great many fire brick companies both in Pennsylvania and the adjoining states have offices in Pittsburgh, which is probably the greatest fire brick market in the United States, and possibly in the

world. However, but four of the companies have works in Pittsburgh, and only two of these produce fire brick, the other two making glass pots. Some of the large glass works also make their own glass pots.

Probably the reason there are not more works in Pittsburgh is the absence of refractory clay in that city. So far as could be ascertained there is no high grade refractory clay mined in Allegheny county, and all that is used is imported from other localities. As the clay nearly always occurs associated with coal beds, it is cheaper, as a rule, to manufacture the brick at the clay mine than to ship the clay to the city.

The Harbison and Walker Co. Star Fire Brick Works.—The works of the Harbison and Walker Co. at 22d and Railroad streets, Pittsburgh, is among the largest fire brick works in the State. The company owns works also at Woodland, Clearfield county and Figart, Cambria county. The total daily capacity of the three works is given as 175,000 or 52,500,000 per year.

The Star works were started in Pittsburgh in 1865 and have been in continuous operation since that time. The clay is obtained from different points in Clarion, Clearfield and Cambria counties. The silica or ganister comes from Point View near Hollidaysburg, Pa. The following analyses of their clays are re-published from the company's circular.

Analyses of Harbison & Walker's Fire-clays.

	Benezet.	Clarion.	Allegheny.
Silica,	45.292	56.300	61.983
Alumina,	40.365	31.693	27.246
Peroxide of Iron,	.510	.881	.351
Lime,	.037	.125	.322
Magnesia,	.015	.000	.148
Alkalies,	.136	.105	2.150
Water,	13.608	10.625	7.500
Loss,	.037	.271	.300

This company manufacturers fire-clay brick of different grades for cupolas, furnaces, coke ovens, rolling mills, gas flues, tiles and blocks for retorts, and blast furnace stove brick. They also manufacture Bessemer converter tuyeres, sleeves and nozzles, Star silica brick for open hearth steel furnaces and gas furnaces; grate backs and stove linings; railroad specialties for locomotive engines; carbon and clay brick and carbon brick, a patented product for lining blast furnaces. The carbon brick are also used in the crucibles and boshes of lead,

zinc and copper smelting furnaces. Their trade is not confined to Pennsylvania, but they ship to many distant points in the United States, China and Russia.

They have 72 down-draft kilns, each having a capacity of 35,000, one stack answering for six kilns. Coal is used for burning and the heat from the cooling kilns is discharged into chambers of green brick, with a saving of fuel. They have a continuous kiln having 22 chambers, each holding 17,000 brick. Gas manufactured from coal slack is used in the continuous kiln.

The fire bricks are nearly all made by hand by the usual processes. Most of them are repressed when partially dried. In busy seasons they employ about 15 gangs of molders and repressers. The bricks are dried on drying floors, of which they have two 65x120 and one 65x144 feet.

For certain grades of work the clay is calcined and washed before molding. The calcining is to remove the shrinkage of the clay and the washing is to remove impurities, processes which are rarely if ever used in the smaller works.

The large works, the variety of clay and materials used enable them to manufacture and keep in stock a great variety and quantity of the different refractory materials, and being in the center of the great manufacturing industries of western Pennsylvania where there is a correspondingly great demand for refractory ware, they have a large trade.

Iron City Fire Brick Co.—The Iron City Fire Brick Co. was organized in 1896 by the consolidation of the Iron City Works of W. A. Scott & Son, at Pittsburgh, and W. R. Miller's Sandy Ridge Works, in Centre county. The capacity of both works is given at 15,000,000 fire bricks per annum.

The clay used in the Pittsburgh works is all obtained from other points and shipped in to the works. They make several grades of brick, known under the trade names of: 1. "Iron City," a high grade refractory brick, used in heating, puddling and copper furnaces. 2. "Murtland," a sand brick, for use in necks and clamps of puddling furnaces. 3. "Silica," a silica brick for use in open-hearth furnaces and glass furnaces.

Pittsburgh Clay Pot Co., Rebecca Street, Allegheny, Pa.—The Pittsburgh Clay Pot Company has an extensive trade in all grades of glass pots over all parts of the United States and have learned from experience the grades of clay best adapted to the different varieties of glass. In order to supply all branches of the trade they keep a large stock and variety of pots on hand, the stock valued at about \$200,000 at present. This enables them to supply orders promptly, often an important item, as the manufacture of a large glass pot is the work of

weeks. They have 80 acres of floor space in their large factory and employ about 150 men and women.

They use fire-clay from Fayette county, some from Armstrong county and some from Clearfield county. The Fayette county clay, they say, is the most satisfactory of any they get from this State. They also use clay from Missouri, Ohio, and West Virginia. They claim that the best clay occurs in the largest quantities in Kentucky, the bed being thirty feet thick, but the transportation is too difficult to permit its transfer with profit. They import some clay from Germany for special grades of work, the yearly imports estimated at 3,000 tons.

Of the glass companies that make their own glass pots, those that were interviewed get most of their clay outside of the State.

The Phoenix Clay Pot Co., at 350 Brushton avenue, Pittsburgh, obtain their clay in Missouri, Ohio and Germany. They manufacture glass pots, tank blocks and furnace brick, their chief markets being Pennsylvania, Indiana, Denver and Canada.

ALLEGHENY VALLEY FIRE-BRICK WORKS.

Outside of the Kiskiminitas-Conemaugh valley described below the only fire brick works visited in the Allegheny valley are the ones at Manorville and Cowanshannoc, both owned by the Phoenix Fire Brick works.†

The two large brick companies at Kittanning, described elsewhere, make some fire brick, but their chief trade is in building brick, paving brick and drain tile. See chapter VII.

Phoenix Fire Brick Works, Cowanshannoc, Pa.—The works are on the east side of the Allegheny river, about three miles north of Kittanning and about a quarter mile below Cowanshannoc station. The mines and works are said to have been operated at this point for about 17 years, how long by the present company is not known.

They make high grade fire brick only and mold by hand. The flint clay is obtained from some point or points further up the valley. The plastic clay, which belongs near the base of the lower coal measures, is mined on the hill about 100 feet above the works and run to the works on a tramway. The products are shipped on the Allegheny Valley Railroad.

Phoenix Fire Brick Works, Manorville, Pa.—The works at Manorville are owned by the same company, Isaac Reese & Sons, as those at Cowanshannoc, described above. The office of the company is located at Manorville. The works at Manorville make only silica

†Lack of time prevented me from ascending the Allegheny Valley above Cowanshannoc. Fire clay is said to be mined and shipped from several points above this.

brick and the company claims that they were the first to manufacture silica brick in the United States. The plant was established in 1864 by Isaac Reese and re-organized in 1896 as Isaac Reese & Sons. Their silica brick are widely known throughout the State.

The silica or ganister is obtained in part from points further up the Allegheny valley and in part from East Tyrone, Blair county. They ship in the limestone and burn the lime at the works.

The bricks are made in hand molds but the clay is handled with shovels instead of by hand, as with other brick, because of the corrosive action of the lime on the flesh.

The works are situated on the Allegheny Valley Railroad at Manorville station, thus having excellent shipping facilities. The Pittsburgh office of the company is in the Lewis block.

For many years fire-clay has been mined and shipped to various points from the Reynolds property, a mile or more north of Kittanning. Clay has been shipped from here at least as early as 1880, how much earlier is not known. No particulars are at hand concerning the industry except such as are given in the Second Pennsylvania Survey* Report.

KISKIMINITAS†—CONEMAUGH VALLEY.

In the Conemaugh valley there are fire brick works at Salina, Black Lick, Bolivar, Lockport and Johnstown, and fire-clay mines at South Fork and Mineral Point. Some of the oldest and some of the largest fire brick industries in the State are found in this valley.

Kier Bros., Salina, Pa.—At Salina, on the West Pennsylvania Railroad, on the south side of the Kiskiminitas river, is located the fire brick works of Kier Bros., one of the oldest in the State, as they were established in 1845, more than 50 years ago. The Pittsburgh office of the company is in the Stevenson Building.

They manufacture high grade fire brick. They have seven kilns and a daily capacity of 14,000 brick, employing 50 men and boys at the works. Pittsburgh is the chief market, but they ship to Cleveland, Boston navy yard and other points.

They use the clay taken from their own mine at the works. It is at the same geological horizon as the Bolivar clay. The dip of the strata is to the eastward and the drift from which the clay is taken runs down the first hundred feet at an angle of about 15 degrees, then changes to a more nearly horizontal position.

The mine now extends probably lower than the bed of the river and it is necessary to pump the water from the mine. As the main head-

*Second Pa. Geol. Survey Report, H-5, p. 244, 1880.

†The lower course of the river near its confluence with the Allegheny is known as the Kiskiminitas, and the upper part as the Conemaugh.

ing follows the dip of the rock and the rooms branch off at a slight up grade, the pumping can all be done from one point, the end of the main heading, the rooms all being comparatively dry.

The clay varies from six to thirteen feet in thickness, including both the hard flint clay and the soft plastic clay. The variation in the thickness of the flint clay is even more marked than that of the entire bed, as it in some places will vary from a thickness of twelve or thirteen feet to two or three in the same room. In some places it lies underneath the soft clay and in some places on top. The flint clay is of good quality, in most places quite clean but in some spots it contains the iron ore balls in considerable numbers. As the ore balls are generally black or nearly black and much heavier than the clay they are readily detected and picked from the clay by hand. The following analyses, made by the Second Pennsylvania Geological Survey, will show the chemical character of the clay:

Analyses of Fire-clay from Kier Bros. mine, Salina, Pa.

	No. I.	No. II.	No. III.	No. IV.	No. V.
Silica,	51.920	47.250	40.720	60.520	55.330
Alumina,	31.640	34.350	37.280	24.970	27.841
Protoxide of iron,	1.134	.693	2.448	1.650	2.916
Titanic acid,	1.160	1.990	2.280	1.220	1.140
Lime,	.030	.580	.520	.910	.580
Magnesia,	.443	.090	.002	trace.	.756
Carbonic acid,	none.	.455	.408	.725	.455
Alkalies,	.402	.261	.570	.218	3.916
Water,	13.490	13.695	15.002	9.395	7.495
	<u>100.219</u>	<u>99.364</u>	<u>99.230</u>	<u>99.608</u>	<u>100.429</u>

No. 5 is the plastic clay; the first four are flint clays. Sample No. 1 was collected by Mr. Platt of the Survey, and the other four were sent in by Kier Bros.

The clay is overlain by shale and limestone (Freeport), above which is a bed of coal four feet thick, the Freeport coal.

Black Lick, Indiana county.—There have been three different fire brick works in operation at or near Black Lick station on the Indiana branch of the West Pennsylvania Railroad, but there is only one at present.

The first yard was started on the east side of Black Lick creek, about one and a half miles above the village of that name. It was opened by Kinter, Robinson and Hadley in 1867. After operating it a few years they sold out to Mr. Giddings, who sold to Mr. Meldron about 1873, who continued to operate them until five or six years ago, when the buildings burned and have not been rebuilt. There were three rectangular kilns, the remains of which are still standing.

The Burl Fire Brick Co.—Mr. Kinter after his severance with the above yard formed a partnership with Mr. Thompson and started the

present works in 1873 about 150 yards north of the Black Lick station on the Indiana Branch of the West Pennsylvania railroad. It started under the name of the Black Lick Manufacturing Co. They failed in 1878, and Mr. Meldron, who operated the yard above mentioned, purchased it and continued it under the name of the Black Lick Manufacturing Co. until 1895, when he failed and the works stopped for a time.

They were re-opened in April, 1896, by Messrs. Kline and Mahan, and Mrs. Meldron, under the name of the Burl Fire Brick Co., under which name it is now operating. Owing to the dull times they were closed for two or three months in the summer of 1897, but are now (August, 1897) again in successful operation.

They make fire brick of different kinds, a few buff building brick, some paving brick and some sand brick. Their chief trade is in coke oven brick and in No. 1 furnace and mill brick. For the No. 1 brick they use flint clay from Blue Ball in Clearfield county, mixed with their own plastic clay. For the coke oven brick they use clay from their own mines, both flint and plastic clay. They have made a few buff building brick from their plastic clay and a few paving brick from the plastic clay and shale mixed, and some silica brick from ganister in the form of boulders picked up on the surface about the mines.

The clay is obtained from the mines at the foot of the west slope of Chestnut Ridge about one and a half miles east of the village of Black Lick. The mines have been operated about 30 years and were at one time connected with the works at the railroad by a tramway, but this has fallen into disuse, and for several years the clay has been transported from the mines to the works on wagons.

The clay overlies the Pottsville conglomerate at the base of the lower productive coal measures. It varies in thickness from three to eleven feet, averaging about seven or eight feet. It contains many ore balls or segregations of iron ore, and must all be hand picked before using. In some places the clay is clean and free from iron for a thickness of several feet. In many places it is much seamed and broken, the seams being stained with iron.

The clay has nearly all been obtained by stripping off the overlying material and then removing the clay. As the stripping becomes much thicker in the hill the opening has been pushed along the base of the hill, and starting on the creek bank it is now more than a quarter of a mile long. They attempted at one time to drift into the hill after it, but the plan was not found profitable and was soon abandoned. In most places where it has been worked the clay is covered with sand, clay and sandstone boulders of the terrace deposit. As the opening is carried back into the hill the clay gains a sandstone rock covering. The sandstone boulders from the terrace deposit are used as ganister in making the silica brick.

The following analyses of the flint clay (No. 1) and the plastic clay (No. II) were made by the Pennsylvania Geological Survey of samples from this mine about 1877:*

Analyses of Fire-clay from Black Lick, Pa.

	I.	II.
Silica,	64.830	68.490
Alumina,	23.950	18.460
Protoxide of iron,	.900	1.566
Titanic acid,	.880	2.150
Lime,	.110	.230
Magnesia,	.187	.551
Alkalies,	.296	2.755
Water, etc.,	9.390	6.310
	100.543	100.512

About 1872, Dr. T. P. Simpson, now of Pittsburgh, is said to have started a brick yard further up Black Lick creek, about two or three miles above the village. He burned a few bricks, but the difficulty of getting them to market is said to have deterred any further work.

The Bolivar clays.—As fire-clay has been mined and manufactured at Bolivar for more than half a century, the clay resources have been pretty well exploited.

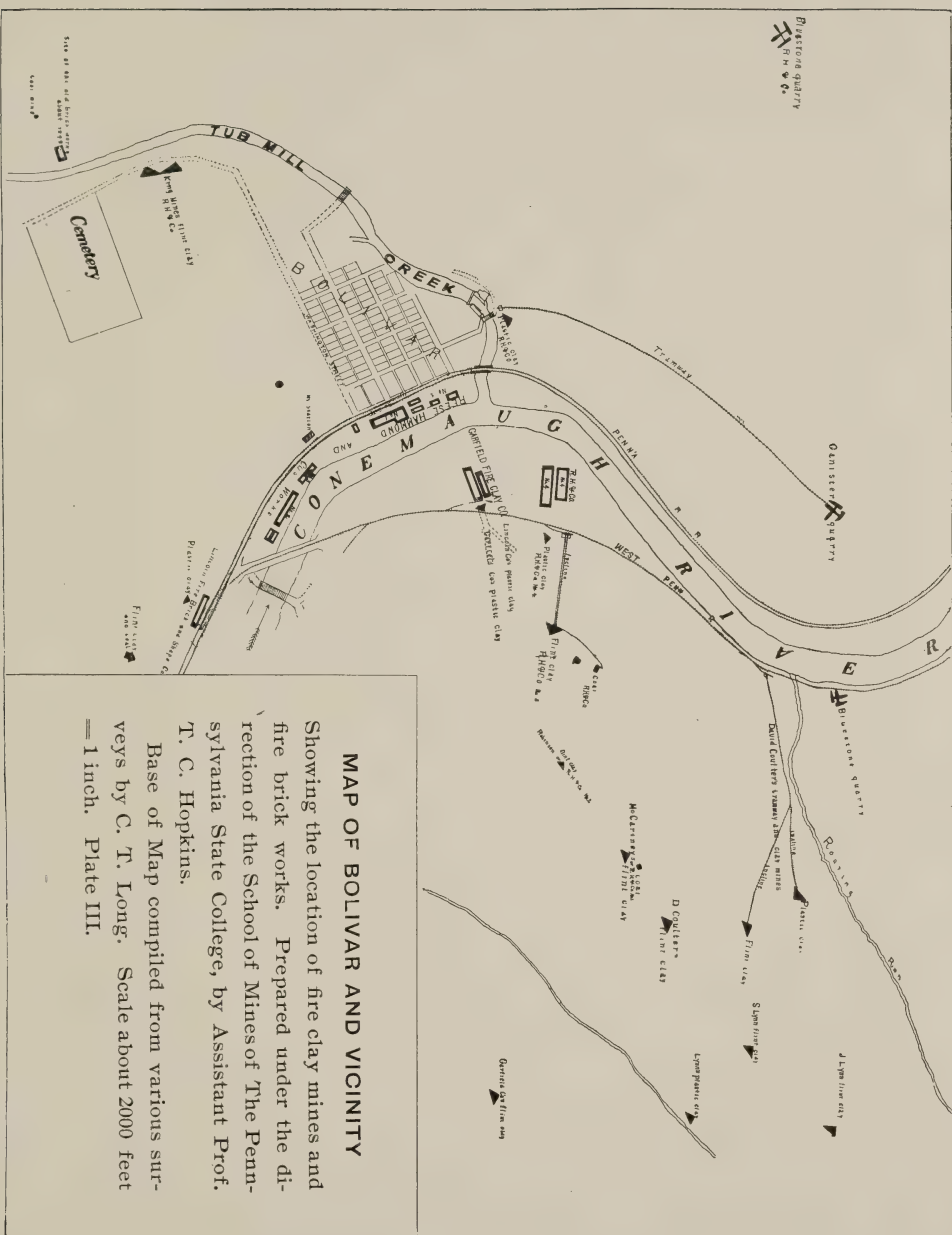
The following section was made by the 2d Pa. Geol. Survey about 20 years ago:

Section of Strata at Bolivar.† (Stevenson).

	Feet.	Inches.
Mahoning sandstone,	20	..
Clay,	3	..
Upper Freeport coal,	8	9
Drab fire-clay,	3	..
Sandstone 2 feet, clay and iron ore 3 feet, coal 4 inches, clay and shale 30 feet,	35	4
Sandy shale 25 feet, fissile shale 30 feet,	55	..
Lower Freeport coal 1 foot 5 inches, clay and shale 6 feet, limestone 3 feet,	10	5
Shale 45 feet, Upper Kittanning coal 1 foot 6 inches, fire-clay 1 foot 6 inches, limestone 1 foot 6 inches,	49	6
Concealed,	47	..

*Second Pa. Geol. Survey, Vol. H4, p. 194.

†Second Pa. Geol. Surv. Rep., 1877, K K K, Ligonier Valley, page 153.



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View of the flint fire-clay quarry on the King property, Bolivar, Pa. The clay was formerly mined in drifts, remnants of which are shown on the face of the quarry. It is now worked from the surface. It is the Bolivar or Upper Freeport clay.



View of the flint fire-clay quarry on the King property, Bolivar, Pa. The c

	Feet.	Inches.
Sandstone 40 feet, shale 12 feet,	52	...
Clarion-coal 1 foot 6 inches, fire-clay 2 feet,	3	6
Concealed 25 feet, shale 20 feet,	45	..
Concealed 35, Brookville coal blossom, shale 15 feet, ..	50	..
Pottsville conglomerate,	..	..

This section will give the general order of succession of the strata, but not a very accurate idea of the thickness of the different beds at the present workings. In the various openings examined by the writer during the past summer all the clay beds that have been worked show a greater thickness than is designated on the section. There is also such a variation in thickness of the intervening beds that it is in places difficult to correlate the beds with those on this section. This may be due in large measure to local variations both in the character and in the thickness of the strata.

The most important bed of clay is that underlying the Upper Freeport or E bed of coal and widely known throughout the State as the Bolivar clay. It varies greatly in thickness, ranging from six to twenty-five feet at different points in the State. Practically all the flint clay used at and shipped from Bolivar, except the little shipped in from other points, comes from this bed.

On the south side of the river it has been mined extensively over a large area on the King tract, owned and operated by Reese, Hammond & Co., and known as their "King Mines," about half a mile southeast of Bolivar, on the slope east of Tub Mill creek (see plate III), near the base of the ridge, where it has been worked for many years, at present on a small scale compared with the operations of former years. The clay was formerly obtained by drifting into the bed in underground workings, but lately the overburden has been removed and most of the clay quarried from the surface, showing a face of clay 18-20 feet in thickness. The clay contains much iron oxide in the form of nodular secretions or segregations, known among the mining men as "ore balls." So abundant are these in certain spots as to give to the quarry the appearance of an iron mine. The ore is in general more abundant in the upper part of the clay bed than in the lower part, and most abundant near the outcrop of the clay. The ore balls are readily distinguished from the clay by their color and weight and are picked out by hand in the mining. The clay is transported on trucks on a tramway to the edge of the village, about half way to the works, and the remaining distance by wagon. See plate IV for view of this mine.

Another point south of the river where the flint clay is mined is on the property of the Lincoln Co., formerly known as the Enterprise. The clay is here mined on the hillside more than a hundred feet above the works (see plate III). The bed is 18-20 feet thick and over-

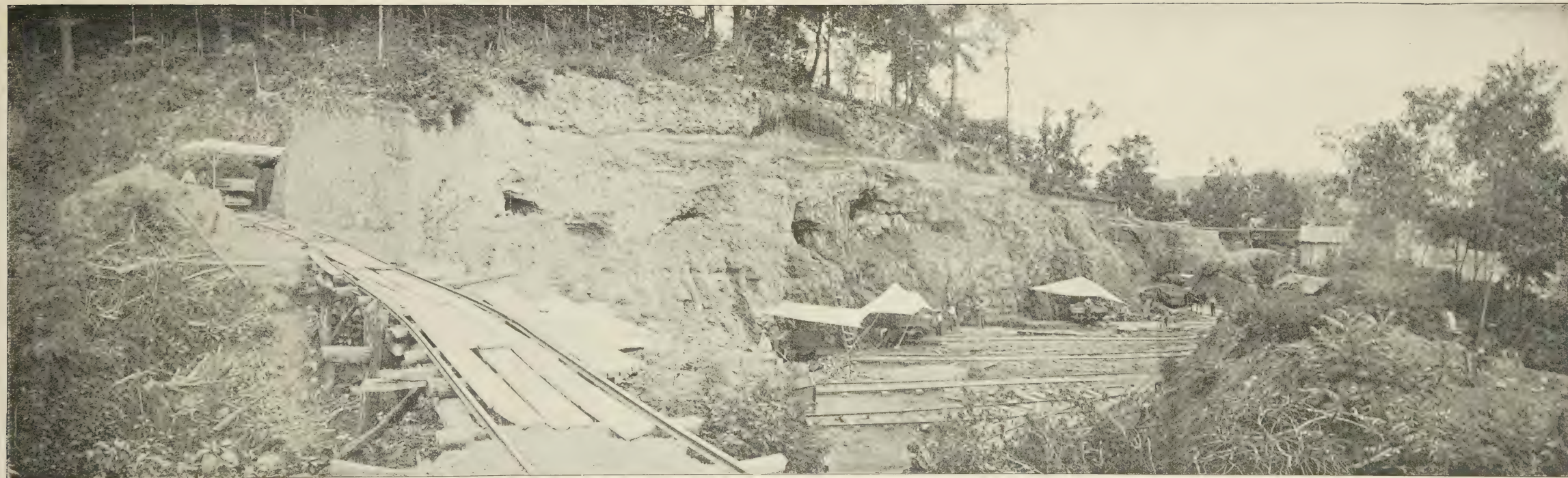
lain by about eight feet of shale and "soapstone" followed by six feet of coal. The clay is obtained by underground working. In some places the entire thickness of the clay is removed and in others only the upper part, about six to eight feet thick, which is quite dark in color and is called the "black clay." It is thought to be of superior quality to the lower or lighter colored part of the bed. In one place in the clay mine an inclined opening has been made from the clay mine up through the overlying shale to the coal, which is run down on an inclined track and brought out at the same opening as the clay. This opening is on a bench of the hill several hundred yards distant from the works and the clay is run in cars on a tramway along the bench of the hill to the head of the incline, where it is run down to the works by gravity.

On the northeast side of the Conemaugh river, in Indiana county, opposite Bolivar, this upper clay bed has been worked in a number of places, as shown on plate III. The opening which is worked most extensively at the present time (1897) is that belonging to Reese, Hammond & Co., recently opened on the point of the hill overlooking the West Penn Railroad, to which there is an inclined railway direct from the clay quarry. Clay was formerly mined at this point from shallow drifts or underground workings, but the company is now removing the overburden and quarrying from the surface. At present only the high grade clay is used, the other being thrown over the dump. The aim is as soon as the new paving and building brick works are completed to utilize all or at least the greater part of the material in the different grades of brick. The present face shows about 22 feet of flint clay, the upper few feet containing much iron, overlain by four to five feet of plastic clay, followed by seven to eight feet of coal. While part of this is now waste material, all of it, except possibly the iron ore, can be utilized to good advantage in the manufacture of different kinds of brick, and the company expects to do so at an early day. The coal is of good quality and can all be used in the works. At present the coal is mined two or three hundred yards further north, where it has a better roof. It is brought on a tramway to the clay mine and lowered to the railway on the same incline as the clay. Part of the material overlying the coal can be used, and the only limit to the extent of the surface workings will be a thickness of the overlying sandstone too great to be removed economically, only sandy soil and boulders having been removed so far. However, should this overlying sandstone prove to be good building stone or even good ganister for siliceous brick it may more than pay for its removal. Under any condition the supply of material is scarcely limited as the supply obtainable by extending the work along the slope is almost inexhaustible, to say nothing of the possibilities by mining underground. See plate V. and fig. 16 for views in this clay mine.

PLATE V.



he clay is about 22 feet thick overlain by impure clay, coal, and sandstone.



View of the flint fire-clay quarry of Reese, Hammond & Co., Indiana Mine No. 3. The clay is the Bolivar flint clay, which underlies the Freeport, or E coal. The clay is about 22 feet thick overlain by impure clay, coal, and sandstone.

A few hundred yards north of east from the above clay quarry along the southeast slope of Chestnut Ridge are three other underground mines of flint clay. The one the farthest away is known as the David Coulter mine, from which the clay was shipped to Lockport for gas retorts. It has been idle for fifteen years, since Mr. Coulter opened his mine on the other side of the hill. The other two mines between Coulter's and the railroad, belong to Reese, Hammond & Co., their No's 1 and 2, and were originally known as the Robinson mine and McCartney's mine. The clay from the mines when they were first opened was hauled by wagon to the works at Bolivar, but the coal mine of the No. 3 works described above, has been driven through the hill and the clay from No's 1 and 2 mines is now hauled through the hill, through this coal mine and sent down the incline to the railway from the No. 3 mine.

Probably the oldest flint clay mine on the north (east) side of the river is that designated on the sketch as the Garfield flint clay. It lies about a mile east of Bolivar and was originally operated by Reese, Hammond & Co., but is now operated by the Garfield Co. It is the same geological bed as the others described above, but owing to the southeast dip of the strata it lies much lower in the hill. This mine has been operated many years and the clay has been removed from many acres. The clay is transported by wagon to the Garfield works.

David Coulter operates a flint clay mine in the same bed of clay near the top of the ridge on the south side of Roaring run.

Other openings in the Bolivar flint clay on the north side of the river are those marked J. Lynn and S. Lynn on plate III, both of which are now owned by Reese, Hammond & Co., but have been idle for many years on account of the cost of transporting the material to the works.

There is said to be a higher bed of flint clay called the upper Bolivar clay, which is found only in remnants, "pots," on the hilltops. It is reported to be highly refractory but not worked on account of its scarcity.

The clay next in commercial importance is a bed of plastic clay about 200 feet below the flint clay. The thickness of the intervening strata, however, is not uniform and varies considerably at different points. This bed furnishes practically all the plastic clay used at Bolivar, besides some shipped to other points, and is mined by all the companies above mentioned. Reese, Hammond & Co. mine it in two places, one near the mouth of Tub Mill creek on the south side of the river, one on the north side of the river in the hill below their flint clay mine No. 3. The Garfield and the Lincoln companies each mine the clay near the Garfield works, both running their clay from the same opening under the railway. David Coulter mines it on the

same hillside, with his flint clay on Roaring Run, at about 175 feet lower level, and runs it to the railway on the same tramway.

This bed of plastic clay really consists of two beds known locally as the upper soft clay and the lower vein, but in one opening, that of Reese, Hammond & Co. No. 4 on the north side of the river, the material between the two parts is sufficiently thin to permit the working of both beds together. In this mine the material between the two clay beds dwindles to but a few feet in thickness, and in places less than a foot, and consists of a thin layer of hard sandstone (ganister), and an impure sandy clay, but practically all the material is used for some purpose or other in the various kinds of brick. The sandstone is used for ganister and the clay mixed in with other clay for brick of low refractory power. In the other mines only the upper part of the clay, about 6 to 8 feet thick lying above the sandstone and called the upper soft clay, is worked. This is said to be a good quality of plastic clay and is used almost exclusively although there is another bed between this and the flint clay overlying and one or two beds said to occur at a lower horizon. One of these lower beds has been tested and found to be less refractory, hence has not been used but may be useful later in making vitrified brick.

The Bolivar clay is said to be not the best for certain grades of refractory ware where the heat is intense and continuous, so that some clay is imported from other points, some from South Fork and some from Blue Ball and Moshannon in Clearfield county and some ganister for the silica brick from Blair and Huntingdon county, but the bulk of the products is made from native clay. Almost every grade of brick can be made from it by the proper selection and mixing of the clays that comes from experience.

The Bolivar clay it is claimed will make a more porous and elastic brick than other clays that stand a higher heat, which makes them adapted to uses where they are subject to frequent and sudden changes of temperature, such as puddling furnaces, pottery kilns and coke ovens. The elasticity of the coke oven brick is certainly severely tried when they are heated to a high temperature and cooled by having cold water from the hose turned on them.

Dr. Stevenson in the Pennsylvania Survey report* 20 years ago, says of the Bolivar clay: "The Bolivar clay has a wide reputation and at one time the brick made from it were thought to be hardly inferior to those from the Mt. Savage region." He further says that the high prices previous to the panic of 1873 caused a carelessness in selecting the clay that almost ruined their reputation. If one may judge from the growth and prosperity of the works at the present time, they have regained their good reputation, as the bricks are not

*J. J. Stevenson, 2d Pa. Survey Report KKK, 1877, p. 248.

only sold in large quantities in the State, but are widely shipped to distant states and even to foreign countries.

Below we give the analyses of two of the clays used at Bolivar and one of the grades of fire brick.

Analyses of Bolivar Fire-clay and Brick.

	1	2	3
Silica, SiO_2 ,	43.46	63.81	53.08
Alumina, Al_2O_3 ,	41.61	26.39	43.41
Ferric oxide, Fe_2O_3 ,	1.03	1.23	2.44
Lime, CaO ,	.24	trace.	.33
Magnesia, MgO ,	.09	trace.	.18
Loss on ignition,	13.29	9.12	.26
Total,	99.72	100.55	99.70

No. 1. Flint fire-clay from South Fork, Cambria county.

No. 2. Westmoreland county flint fire-clay, King mine of Reese, Hammond & Co.

No. 3. The "Acme" fire brick made by Reese, Hammond & Co.

All the analyses were made in the chemical laboratory at State College.

Historical.—Bolivar is one of the oldest centers of the fire-clay industry in the State of Pennsylvania, and is said to be the second oldest in the United States, the Mt. Savage works, Maryland, being the oldest.

From all accounts James Glover was the pioneer in the industry. He came from the Mt. Savage works in Maryland about 1842 or '43, when he discovered the fire-clay at Bolivar, where he was engaged afterwards in the fire-clay business for more than 20 years, having associated with him several different partners in that time. However, the first bricks made at Bolivar were made by Mr. Glover and his family in a small factory operated by water-power on Tub Mill creek. He transported the brick to Pittsburgh by boat on the old Pennsylvania canal, which was then in operation. At Pittsburgh Mr. Glover himself went out soliciting orders for the brick and had great difficulty in selling them, but he managed to dispose of the boat load, and they proved to be of such good quality that the people who bought them soon began to inquire for the old Scotchman from whom they had purchased fire brick. Thus did Bolivar fire brick early acquire a reputation in the markets of the State.

Of the different partners that Mr. Glover had associated with him at Bolivar, Mr. Kier appeared to be the most active and Glover and Kier was the firm that is said to have done the largest business in fire brick during the first quarter century following 1843. Mr. Glover

was at one time in partnership with Messrs. Baxter and Harley under the firm name of Glover, Baxter and Harley. Mr. Glover is said to have first started works near the mouth of Tub Mill creek, later at two different points up the creek. The site of one, the only one known, is shown on plate III. About 1862 he is said to have sold out his interests to Mr. Thomas Boyd and removed to Louisiana.

Mr. E. Robinson was early connected with the fire-clay interests at Bolivar. In 1857, in partnership with Mr. Benny he constructed the works near the depot at Bolivar, which he operated for several years, and which after being in the hands of several different parties were sold in 1867 to Reese, Hammond & Co., who still operate them. Mr. Robinson went to Black Lick, in Indiana county, where he constructed fire brick works, which he sold in a few years and returned to Bolivar, where he built the Enterprise Brick works, now owned by the Lincoln Fire Brick and Shape Co. .

Reese, Hammond & Co..—One of the earlier pioneers in the brick industry, and probably one who has done more than any one else to make the Bolivar fire brick well known throughout the United States, is Mr. James Hammond, who came from Achonry, County Sligo, Ireland, to America in 1851, and after spending one year in eastern Pennsylvania, came to Bolivar in the spring of 1852 and secured employment with Mr. Glover in the fire-clay business, with whom he remained the greater part of the time until 1865, part of the time as mine foreman. When Robinson and Benny started their works in 1857, Mr. Hammond was Superintendent. In 1865 Mr. Hammond and his brother Thomas bought the Robinson works from Mr. Leibengood and others, and in 1867 took in as partners Isaac Reese and John McMath, forming the company of Reese, Hammond & Co., which has since become so widely known.

Shortly after the organization of the company in 1867 B. F. Reese succeeded Jno. McMath as a partner in the firm. Numerous changes have taken place since that time and Mr. James Hammond is now the only original member of the firm, which however has never changed its original name of Reese, Hammond & Co. The present personnel of the firm is James Hammond, T. M. Berkley, his son-in-law, T. R. Hammond, E. R. Hammond and J. B. Hammond, his three sons and B. F. Reese.

In 1872 they built an addition to their works which they call No. 3, and is so marked on the map. In 1881 they purchased a works that had been previously owned by Thomas Boyd, which now forms their works No. 1, located close to the railroad in Bolivar. In 1883 they purchased the old Glover works, which had been owned immediately preceding this by McCartney, Coulter and Dushane, thus gaining possession of what is probably the pioneer fire-brick works of western Pennsylvania.

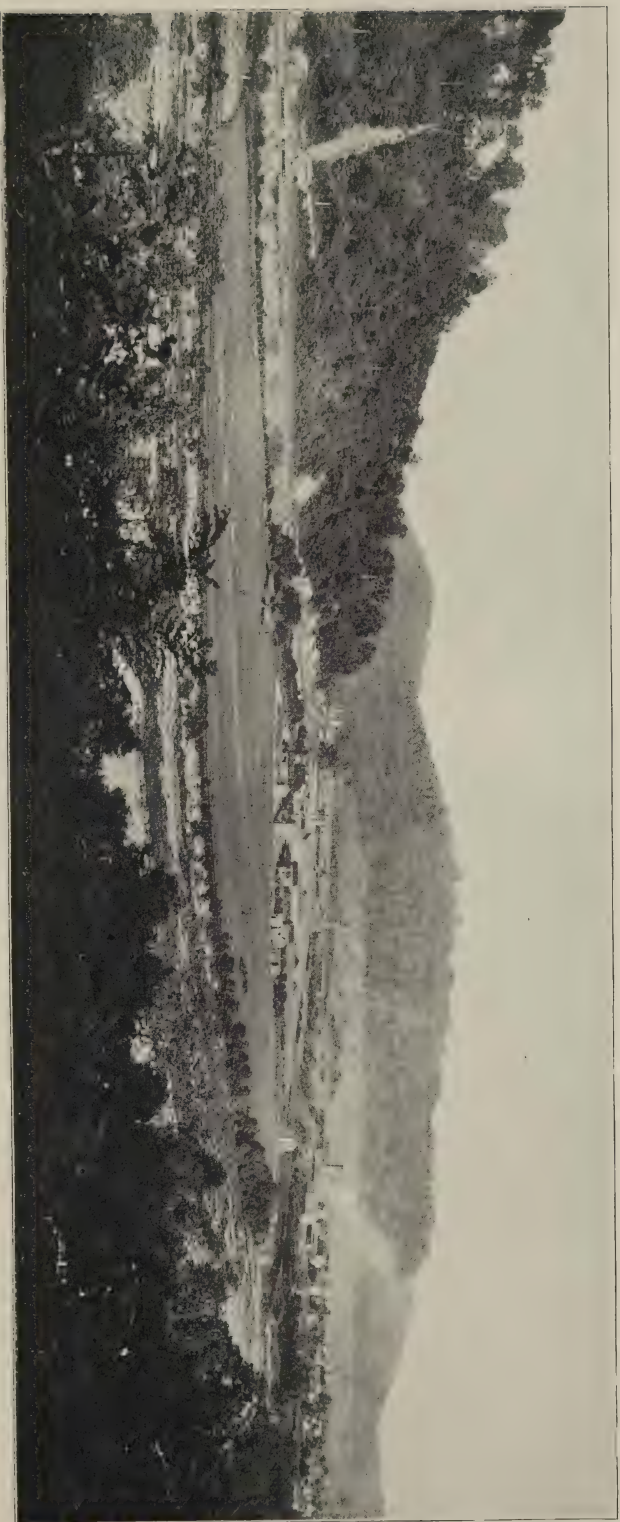


Fig. 21. View of Bolivar, Pa., looking up the Conemaugh Valley. The town is at the right. The first smoke at the right is R. H. & Co.'s fire-clay works, No. 1. The second smoke from the right marks their works No. 2 and 3. The buildings at the middle of view are the works of the Garfield Fire Clay Co. The white area in the upper left hand corner is the dump of R. H. & Co.'s flint-clay mine No. 4, from which the incline extends to the West Penn. R. R. The Penn. Central R. R. is concealed by the trees in the foreground, the telegraph wires showing at the lower left hand corner. R. H. & Co.'s new works, No. 4, constructed since this view was taken, are located on the open space to the left of the Garfield works. See Fig. —.

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This company has apparently been prosperous and progressive from the start, having increased their annual capacity from 1,000,000 in 1867 to 10,000,000 in 1897.

They were obliged to wagon all their clay and coal from the mines to the works, distances varying from one-half mile to one and a half miles for 30 years. They recently secured possession of valuable clay deposits and frontage on the West Penn Railroad in Indiana county opposite Bolivar, and they now have all their clay transported by rail in individual cars at greatly reduced cost. In this year, 1897, they decided to branch out in a new line of brick-making and make vitrified paving and building brick, and they are now (Jan., 1898,) rapidly pushing to completion a new plant for that purpose which they call works No. 4, and which are located opposite Bolivar on the Indiana county side of the Conemaugh river. This promises to be one of the most conveniently situated and best equipped with modern machinery and appliances of the brick works in the State. The company has obtained clay from several different localities, and during the summer of 1897 they were operating six different mines, four of flint clay and two of soft clay, two in Westmoreland county and four in Indiana county. The largest opening, the one from which the largest quantity of material is obtained, is the one recently re-opened at the head of the incline above their new (No. 4) works. (See under clays, page 74). For certain classes of work they ship in clay from South Fork or Clearfield county.

They manufacture a great variety of refractory products, such as blast furnace linings, high grade furnace brick for open hearth steel furnaces, heating furnaces, soaking pits, and a complete line of rolling mill brick and shapes, also special shapes for Bessemer steel converters, for cupolas, brass furnaces, crucibles, potter's kilns and coke ovens; special shapes for locomotive arches, grate settings, stove linings and a general variety of shapes for any purpose where a high grade brick is required.

In the new works rapidly approaching completion they will manufacture vitrified paving brick and different kinds of building brick.

Their largest market is in western and central Pennsylvania, but they ship extensively to New York, New Jersey, New England, Ohio, West Virginia, Virginia, Alabama, Louisiana, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Montana, Washington, also to Canada, and have shipped to South America. The company has for many years shipped fire brick to Montana and Washington, but the freight rates across the continent are so heavy that the company is now meeting competition in Washington from English manufacturers. The present freight tariff is \$15.00 per ton, about \$52.50 per thousand on the brick. They find it cheaper to ship to New York and thence by ocean freight to Washington. They also ship from Bolivar

ganister in a crude state that is used in Bessemer converters. They also ship crude fire-clay for the manufacture of gas retorts.

One of the improvements they aim to put in their new works now in process of erection is the blower system for drying the brick by utilizing the exhaust steam. The new works are located at the base of the hill below their largest clay mine and the force of gravity will be utilized in transporting the clay to the crusher and thence to the grinding pan. An automatic wire-cutting machine will be used and all the latest improvements known in the fire-brick industry.



Fig. 22. Showing crew at work repressing hand-molded fire-bricks, Bolivar, Pa.

They are making the building fire-proof by using steel and brick construction. The advantageous position of these works is shown on the accompanying view, plate III.

The Garfield Fire Clay Co., Bolivar, Pa.—The works of the Garfield Fire Clay Co. are situated on the north side of the Conemaugh river, in Indiana county, opposite Bolivar. They are connected by side track with the West Pennsylvania Railroad, over which, and the Pennsylvania Railroad, the products are shipped.

The works were started in 1889 by the Robinson Brothers, sons of the Mr. Robinson who started the works in 1857, now owned by

Reese, Hammond & Co., and who later, in 1872, started the works now owned by the Lincoln Fire Brick and Shape Co. The Garfield works are still in possession of the Robinson Brothers and have been in continuous operation since they started in 1889, except about a month of the present year (1897), when they were rebuilding the works after a disastrous fire. For two or three years the company was known as Geo. H. Anderson & Co., but Mr. Anderson soon withdrew and the old name was resumed. They are rebuilding on a slightly enlarged scale. The new building will have a floor space for 20,000 bricks per day.

They manufacture many kinds of fire brick and refractory material but their specialties are tiling for locomotives and stove linings. They ship locomotive tiling to many distant points, sending large quantities to the Chicago and Western Railroad for points west of Chicago. They ship tiling as far west as Oregon and east to Maine. They ship some to Cuba, Brazil and China. They have a three years' order for stove linings from one of the large stove works in Chicago.

They obtain the greater part of the clay from their own mines and get some for special work from Blue Ball, Clearfield county, and some from South Fork, further up the Conemaugh. They obtain their plastic clay from a drift at the works, which runs eastward under the railroad track into the hill. The property immediately adjoins that of the Lincoln Co., in fact the clay from both mines are brought to the surface through the same opening. (See plate III.) The clay is only a few hundred yards southeast of the mine of Reese, Hammond & Co., and is the same bed geologically, although it here lies much lower in the hill than in the other mine, owing to the southeast dip of the strata.

The flint clay mine of the Garfield Co. lies about a mile east of their works, which distance the clay is hauled in wagons. It is the Bolivar clay, the same bed geologically as that at the other mines. This mine is said to be the oldest in this vicinity.

Lincoln Fire Brick and Shape Co.—The works of the Lincoln Fire Brick and Shape Co. are situated on the south side of the Conemaugh river and the Pennsylvania Railroad, about half a mile above the Bolivar station (see plate III). The works were established by Mr. E. Robinson, in 1872, and have since been operated by the Enterprise Manufacturing Co., the Bolivar Brick Co., and the present owners, the Lincoln Fire Brick and Shape Co. They are idle at present and have been nearly all this year up to the present time (August, 1897).

They manufactured fire brick and refractory ware of different kinds from clay obtained from their own mines near the works. They obtain the plastic clay from a drift in the hill immediately back of the works, at a level a little above the works. The flint clay is obtained at an elevation of a hundred feet or more above the works and nearly

half a mile distant. The clay is run out on trucks and hauled on a tramway to the head of an incline at the works where it is run on the incline to the crusher. The flint clay (Bolivar) is 18 to 20 feet thick and presents a nice appearance as exposed in the mine. There is in places diffused iron oxide, so that some care is needed in selecting the clay. The upper part of the bed, six to eight feet thick, is very dark colored, the "black clay," and is considered the most valuable part of the deposit. In some places only the upper black clay is worked, the lower, lighter colored, less valuable clay, being left for a more convenient season.

The Lincoln Company has an experimental coke plant at the brick works, in which the aim is to save the by-products. It is also idle.

David Coulter's clay mines.—David Coulter, who resides in Bolivar, has been mining and shipping fire-clay from the vicinity of Bolivar for many years. He is at present operating two mines in Indiana county, nearly two miles northeast of Bolivar, on the north side of the ridge from the other clay mines. (See plate III for location.)

He has been mining the soft or plastic clay about ten years, working a thickness of five or six feet, corresponding to the upper one of the two beds worked by Reese, Hammond & Co., on the south side of the hill. The flint clay, about 250 feet above the plastic clay, is the Bolivar clay. He works only five to eight feet of the upper part of the bed, which he thinks is a superior quality for gas retorts, for which it is used.

There is an incline from both the soft clay and the flint clay to the tramway at the foot of the hill, which runs down the Roaring run hollow to the side track on the West Pennsylvania Railroad on the bank of the Conemaugh river. All his clay is shipped to James Gardner, Jr., Lockport, where it is used in making gas retorts.

Mr. Coulter formerly operated a clay mine on the south side of the hill, about half a mile south of his present mine.

The Lynn clay mines, designated on the accompanying map (plate III), were not visited by the writer. They now belong to Reese, Hammond & Co., and are not operated because the cost of transportation to the works is too great.

Jas. Gardner, Jr., Lockport, Pa.—The fire-clay works of Jas. Gardner, Jr., are located on the south side of the Conemaugh river between the river and the Pennsylvania railroad at Lockport station, two miles above Bolivar, and have been in operation since 1863. Besides the ordinary gas retort they make special retorts for iron and steel mills, and have recently shipped some special forms to a gold mining company in Georgia. Their chief trade, however, is in gas retorts, which are shipped to all parts of the United States. In the manufacture of fire-clay gas retorts they have no rival in Western Pennsylvania. The

gas retorts vary in size, some of the larger ones made at Lockport weighing about 2,100 pounds, and standing 15 to 18 feet high. Some are made by hand, a process of several weeks duration, and some are made by machinery. Mr. Gardner has invented much of his own machinery, not simply for molding and building up the retorts, but also for handling them both in the green state and the burned finished product, in putting in and removing from the kilns and loading aboard the cars. He has also an ingenious contrivance for weighing the clay before mixing.

While gas retorts form the bulk of the product, fire bricks and other refractory materials are made in small quantities.

Mr. Gardner obtains some of his clay from Mr. David Coulter at Bolivar, some from South Fork up the Conemaugh and some from Clearfield county. Formerly clay was mined in the hills near the works, but it is now said to be more profitable to buy the clay from other points than to mine it at Lockport.

A commendable feature that a visitor notices in Mr. Gardner's works is the neatness and cleanliness about the buildings and the yard, such a striking contrast to the average brick yard.

A. J. Haws & Son, Johnstown, Pa.—The works of A. J. Haws & Son were started in 1859 by Mr. A. J. Haws, and have been under his management ever since with the aid of his son H. Y. Haws, who became a member of the firm about 1879. The company claims a yearly capacity of 15,000,000 bricks, including 500,000 or more silica brick. Including the men in their coal mines they employ about 400 men. It thus ranks among the larger and older fire brick works in the State.

They make a specialty of blast furnace linings, but manufacture all kinds of fire brick, silica brick, tuyeres, and brick converter bottoms for Bessemer steel works, and nozzles, stopper rod sleeves and runner brick for bottom casts.

The flint clay for the refractory ware they obtain at their mine near South Fork station, on the Pennsylvania Central railroad; the plastic clay comes from a bed about four feet thick that lies 110 feet beneath the works. It is mined along with the accompanying coal (the Miller coal) and elevated through a shaft at the works. The ganister or silica for their silica brick is obtained from Blair and Huntingdon counties.

M. L. Williams & Co., Johnstown, Pa.—M. L. Williams started a fire brick works at Coopersdale on the north side of the Conemaugh river about two miles below Johnstown in 1889. He operated it alone for a number of years, but a few years ago took in a partner, making it M. L. Williams & Co., since which time the works have been enlarging their capacity.

They manufacture only high grade refractory material, mostly specialties for steel works. There is an air of secrecy about the

works, visitors not being admitted. Some of the processes are said to be patented and others kept secret and carefully guarded.

Some of the clay is obtained from the mines on South Fork, but the greater part of it is said to come from the mines at the works. It is said to be a semi-plastic clay about two feet thick mined along with the overlying coal, the "four-foot bed" which is about three feet and eight inches thick.

Hiram Swank's Sons, Johnstown, Pa.—Mr. Hiram Swank established a fire brick works in what is now the 6th ward of Johnstown as long ago as 1856, which were in operation until about six years ago, when new works were constructed in the 10th ward on the line of the Penn. Central R. R. This is on the opposite side of the town from the other companies mentioned. The business is now managed by Hiram Swank's sons, Chas M., Albert F. and Milton R. Swank. They manufacture centre and bottom plate runner brick, sleeves, nozzles and Bessemer tuyeres, also vitrified buff-colored building and paving brick.

They operate a clay mine about half a mile east of the works and ship some of their clay from South Fork Station, a few miles further up the valley.

THE YOUGHIOGHENY VALLEY.

It will be seen on consulting the map (plate I) that there is a large number of fire brick works in the Youghiogheny valley. There is also quite a variety in the character of the products. As it includes the extensive Connellsville coke region, the manufacture of coke-oven brick is naturally an important feature. Four of the works manufacture silica brick and one makes basic brick.

Layton Station.—Layton Station on the B. & O. R. R., below Connellsville is quite a center for refractory ware as there are three companies in active operation, one works idle, and another idle factory but two miles distant. There is also a fire-clay mine that ships clay to Pittsburg for the manufacture of glass pots.

The Layton Fire Clay Co. operates the first fire-clay works met in ascending the Youghiogheny river. The works are on the B. & O. R. R., on the east side of the river, about half a mile below the railway station. The main office is in McKeesport, Bowman Bros. forming the company. These works have been operated by the present company for six or seven years and for a number of years previously by other companies. They have a capacity of 30,000 bricks per day, and manufacture fire brick, buff building brick and paving brick.

The fire bricks are made by hand and the building and paving bricks are made by machine, the Freese auger machine being the one used. Most of the bricks are shipped to points along the B. & O. R. R., in the Youghiogheny and Monongahela valleys, a few being shipped on the P. & L. E. R. R.

The fire-clay is obtained from a bed in the hill about 50 feet above the works, where drifts are run into the bed and the clay run out on cars and dumped at the works. Both hard and soft clay come from the same opening, the relative proportion of the two varying in different parts of the bed. The hard clay overlies the soft and at the mouth of the drift is from one to two feet thick and varies but little for the first 50 feet from the outcrop, after which it thickens, and at 100 feet from the outcrop it is four or five feet thick, and is said to increase further in the hill to eight or twelve feet, but runs quite irregularly in thickness. The entire bed, both soft and hard varies from six to twenty feet in thickness. The clay is overlain by a heavy bed of sandstone and underlain by a shaly sandstone. The adjacent strata as exposed on the west bank of the river opposite the works show as follows:

Section at Layton Station.

	Feet.
Heavy bedded sandstone suitable for building stone,	30
Sandy shale,	8
Sandstone heavy bedded,	6 to 8
Fire clay, hard and soft,	12
Thin bedded sandstone,	5
Shaly sandstone and shale,	25

The soft clay contains a few iron balls but none have been found in the flint clay.

About 50 feet above the fire-clay on the hill is a bed of blue clay said to be from six to eight feet thick, which is used by the company for making building and paving brick. It will vitrify at a much lower temperature than the fire-clay.

The Stuart Fire Brick Co's works are situated at Child's Station, on the Pittsburgh and Lake Erie Railroad, on the west side of the Youghiogheny river, about half a mile above Layton station. The works were started in the spring of 1893, by Mr. William Stuart, who later opened the works just across the river, now owned by the Silica Brick Co., and the same person who still more recently opened and now operates the brick works at Kingston, near Ligonier. The Pittsburgh office of the present company is in the Conestoga building.

They make silica and sand brick only. The silica is quarried about half a mile from the works and run in on a tramway. It is said that there was a sand works at one time near the site of the brick works that used all the suitable silica near the works. The company claims to have two beds of soft fire-clay on their property, one about five or six feet thick, the other about eight feet. Both have been opened but not used in any quantity.

Silica Brick Co., Limited, is the name of the company that owns the works on the east side of the river opposite the works of the Stuart Company and about half a mile above the Layton station on the B. & O. R. R. They are not in operation at present (August 1897) and but little information could be obtained regarding them. The works are said to have been started but a year or two ago and stopped for want of orders.

They advertise all kinds of fire brick, shapes and tiles, also Pompeian and buff building brick. There are three kilns now standing full of silica brick. The silica and soft fire-clay are obtained on the company's property adjoining the works.

Mrs. M. J. Wurm has been shipping fire clay since 1887 from her mine on the hill about a mile east of Layton. It is a superior quality of clay for glass pots and is said to be shipped for that purpose to Pittsburgh. The clay has been mined on a small scale and shipped at the rate of a few carloads per year. The bed is said to be from four to six feet in thickness. The pot clay is carefully selected by hand from the run of the mine and the remainder is used for common fire brick.

The analysis of this glass-pot clay shows its purity and adaptability for the purpose. It will be noticed that the total fluxing constituents are less than two per cent.

Analysis of glass-pot clay from Layton Station.

	Per cent.
Loss on ignition (water, CO ² , etc.),	9.29
Silica, SiO ² ,	64.89
Ferric oxide, Fe ² O ³ ,	0.29
Ferrous oxide FeO,	0.21
Alumina, Al ² O ³ ,	24.08
Lime CaO,	0.41
Magnesia, MgO,	0.19
Potash, K ² O,	0.87
Soda, Na ² O,	0.16
Total,	100.39
Kaolin base,	59.11
Free silica,	36.75
Total fluxing constituents,	1.83

Other mines have been opened in the vicinity of Layton for fire-clay, but none of them are in operation at present.

Lavenia Station.—The Crescent Fire Brick Co. formerly operated

a brick works at Lavenia Station, on the Baltimore and Ohio Railroad, about two miles above Layton. The works are now idle with no one in charge. The machinery has not been removed and is rusting badly. It could not be ascertained how long they operated or how long they have been idle. They are now advertised for sale by the Fidelity and Trust Company, Pittsburgh, Pa.

The clay was obtained from two openings, one about 50 feet, the other about 100 feet above the works. The lower opening is in a bed 10 to 12 feet thick, of semi-plastic clay, called flint clay, that is overlain successively by six inches of coal, 20 inches of shale and clay, two feet of coal and a heavy bed of sandstone. The upper bed of clay is seven or eight feet thick at the outcrop and is soft, plastic clay overlain by 30 inches of coal, three feet of sandstone and a heavy bed of black fissile shale. No tests were made of the quality of the clay, but the appearance at the outcrop suggests clay of good quality for buff building and paving brick or low grade refractory brick.

Connellsville, Jos. Soisson & Co.—Jos. Soisson & Co., of Connellsville, is one of the oldest fire brick companies in the State. Mr. Jos. Soisson, the senior member of the firm, operated fire brick works at Portage, No. 8, on the line of the old Pennsylvania canal, from 1859 to 1862. In 1862 the canal passed into the possession of the Pennsylvania Railroad and the brick works stopped at that point.

The company now operates three large works in the immediate vicinity of Connellsville, known as (1) the Volcano, (2) Davidson, and (3) Moyer works.

Jos. Soisson & Sons also operated works at Rankin Station from 1889 to 1893, under the name of the Crescent Fire Brick Co., where they made silica and other bricks. The works were destroyed by fire in 1893, and were not rebuilt. In the three factories now operated by this company they manufacture different grades of refractory brick, building brick and paving brick. Much of the brick pavement in Connellsville was furnished by them.

The Volcano, the oldest of the factories at present operated by the company, was started in 1864, and is situated on the east side of the Youghiogheny river, a short distance south of Connellsville, on the Baltimore and Ohio Railroad. They manufacture fire brick, building brick and paving brick.

The fire-clay used in the Volcano works comes from the company's mines at Bailey's Point, several miles up the Youghiogheny river from Connellsville. Formerly they obtained all their fire-clay from their mines a half mile or more east of the works on the west slope of Chestnut Ridge. These mines were operated until last winter (1896), when they were abandoned for the more productive ones at Bailey's Point. The debris has fallen into the old mines, concealing the clay so that little can be said of it at present from observation. It is in

the lower coal measures immediately underlying the "four-foot" bed of coal which is here between three and four feet thick. So far as can be judged from the partial opening, the clay bed may vary from 10 to 15 feet in thickness. The analyses of this clay would indicate a highly refractory one, and evidently the only reason for abandoning the mine must have been cost of mining. However, the analysis is not complete and the value of the clay might be greatly changed by the missing eleven per cent.



Fig. 23. View in the lower flint fire-clay mine at Moyer, Pa. A, is a coal seam about 4 feet thick. B, sandstone overlying the coal. All below the coal is fire-clay, 10 to 12 feet thick.

Analysis of fire-clay, Jos. Soisson & Co., Connellsville, Pa.

	Per cent.
Silica SiO_2 ,	55.38
Alumina Al_2O_3 ,	30.42
Iron Fe_2O_3 ,	trace
Lime CaO ,	.52
Magnesia MgO ,	.34
Alkalies K_2O , Na_2O ,	.22
Water H_2O ,	1.70
Total,	88.58

The materials for the paving and building brick are obtained from the clay and shale bank at the Volcano works, which consists of a bed of clay and shale about 25 feet or more in thickness overlain by two to four feet of terrace deposit, consisting of sand and boulders.

The paving brick and building brick are made by machinery, and the fire bricks are molded by hand. The experience of this company is that the hand-made fire bricks give better satisfaction than the machine-made ones.

The tests made by the Connellsville city engineer, Mr. Samuel Foutz, show the Volcano paving bricks to compare favorably with



Fig. 24. View in the upper flint clay mine, near Moyer, Pa. B, sandstone; A, Upper Freeport coal. All below A, flint fire-clay (Bolivar clay).

those from many other well known localities, so favorably that they were recommended for use on the Connellsville streets.

Davidson Works.—The Davidson brick works of Jos. Soisson & Co. are about one mile north of Connellsville between the B. & O. and the Southwest Pennsylvania railroad tracks. The chief object of locating the works here was to get the advantage of shipping over both the railways. This is the newest of the three works, having been founded in 1878. Fire bricks only are manufactured at the Davidson works, the clay for which is obtained from different points, mostly from their mine at Bailey Point. The bricks are hand-molded, and pressed in hand-press when partly dry.

Moyer Works.—The Moyer Works of Jos. Soisson & Co. are situated

on the east side of the Southwest Pennsylvania Railway, about 200 yards south of the Moyer station. The works were started in 1871 and have five kilns in active operation making fire brick only. They use the fire-clay from their mines about two and a half miles east of the works along with some blue clay hauled by wagon from south of Connellsville. They have used some clay and shale from the creek bank near the works but are not using any of it at present. It has presumably been used in the manufacture of building or paving brick, which are not being manufactured at present. The products of these works are shipped over the Southwest Pennsylvania Railroad.

The clay used at the Moyer works comes from the west slope of Chestnut ridge about two and a half miles east of Moyer. It belongs beneath the Freeport coal near the top of the lower productive coal measures at the same horizon as the flint clay at Bolivar. It resembles the Bolivar clay in appearance. A section across the clay bed shows:

	Feet.
Thin bedded shelly sandstone,	12
Coal, Upper Freeport (E),	4
Shale ("Soapstone"),	3 to 4
Flint clay, Bolivar,	10 to 15
Plastic clay mined in only a few places,	3

The coal is not mined except in small quantities. The flint clay, as in nearly all other localities where it is mined, contains numerous iron ore concretions, "ore balls," making it necessary to hand pick it. If properly picked it furnishes a good highly refractory clay. It has a dark-gray color, and splintery to conchoidal fracture.

The clay is mined at present in two openings on the hillside south of the valley. See figures 23 and 24. The clay has been mined here more than a quarter of a century, and that large quantities have been removed is evidenced by the numerous abandoned openings on the hillsides. There are at present, August, 1897, four teams hauling clay from these mines to the works at Moyer.

Bailey Point clay mine.—Jos. Soisson & Co. obtain most of the refractory clay for their Volcano and Davidson works from their mines at Bailey Point on the east side of the Youghiogheny river about eight miles above Connellsville and about half a mile below Bear Creek station on the B. & O. R. R. The mines are near the top of the river hill, about 300 feet above the railroad. There is an incline railway from the level of the mines to the railway side track and a tramway along the bench of the ridge connecting the different openings with the head of the incline. They ship clay from here at the rate of about two cars per day.

The bed of flint clay is 12 to 15 feet thick overlain in places by two to four feet of soft clay and 10 to 18 inches of soft coal. The clay is

underlain by a coarse grained sandstone, and is mined entirely from the surface by following the outcrop along the face of the hill, working it back into the hill until the overburden becomes too heavy to remove with profit. It belongs to the same geological horizon as the Bolivar flint clay, that is just underneath the Upper Freeport or E bed of coal near the top of the lower productive coal measures. One of the seven Soisson sons is in charge of the clay mines. Some years ago clay in considerable quantities was mined from a lower bed, nearly half a mile further north and about 200 feet lower on the hillside. The lower mines have been abandoned for a number of years.

Stewarton.—There is an abandoned fire brick works at Stewarton station on the B. & O. R. R., about six miles above Connellsville that was said to have been operated about two and a half years ten years ago by Houston, Tigert and other of Connellsville. No further particulars could be learned concerning it.

Near the top of the hill about half a mile below Stewarton is a fire-clay mine that has been operated for about 20 years. The mine was opened, it is said, by Mr. John Harbaugh about 20 years ago, and has been operated by different parties since that time. Mr. Paul obtained possession of it this year (1897) and is preparing to work it more vigorously than it has been worked for several years. The clay varies greatly in thickness, in most places being about eight to ten feet, but sometimes thinning to a foot or less. Both flint and plastic clay occur together, sometimes one predominating, sometimes the other. It is overlain by about two feet of soft coal and an indefinite thickness of soft, fissile, brown shale. The clay has been worked by benching along the outcrop on the hillside for a half mile or more, being worked back until the stripping becomes too heavy for removal with profit, which in most places is 15 to 18 feet. A tramway runs along the face of the mine on which the clay is transferred to the head of the incline where it is run down by gravity to the side track on the B. & O. R. R. It is shipped to the fire-brick yard of the McClure Coke Company, at Lemont furnace.

Ohio Pyle.—Messrs. Kennedy and McFarland have mined fire-clay in a small way at several places in the vicinity of Ohio Pyle. At present (August, 1897), they are opening a clay mine near the top of the river hill on the Abram Skinner farm nearly two miles north of Ohio Pyle village. It appears to be the Bolivar clay lying about 15 or 20 feet below the Freeport coal. The present opening which is on the outcrop, shows about eight feet of flint clay, but does not penetrate to the bottom so that the entire thickness of the bed is not shown.

A small quantity of clay was mined at one time in the neck of land near the falls. Clay has also been mined from two openings a few hundred yards above the village, on the east side of the river; in one

opening it is said to be about nine feet thick, in the other about three feet, showing the thickness of the bed to be quite variable. It is probably about the horizon of the Clarion coal. There is an outcrop of fire-clay on the roadside at the Ohio Pyle House that is probably the same horizon as that in the last mentioned openings. Clay has also been mined and shipped from openings along Cucumber run near the falls. It is possible that some of these deposits will be more extensively operated in the future.

Near Connellsville.—On the hill on the west side of the Yougheny river about a mile and a half above Connellsville, there are several beds of fire-clay exposed. An opening was made into one of these deposits near the Frick Company's water works by Mr. Kennedy and others for the Dunbar Fire Brick Co. This clay appears to be of good quality, as shown in the drift which has been driven into the bed 30 or 40 yards. The bed is from four to six feet thick. It has been temporarily abandoned because of difficulty with the water company in obtaining a way for a side track from the mine to the railway. The clay is on the property of Mr. Washington Hurd.

Dunbar, Pa.—The Dunbar Fire Brick Co. operates a fire brick works at Pechin station about half a mile southwest of Dunbar Station, between Connellsville and Unionville, located close to the Southwest Pennsylvania Railroad and has sidetrack to both this road and the B. & O. R. R.

They have a capacity of 20,000 bricks per day and make coke oven brick, mill, paving and building brick, but the largest trade is in coke oven brick, which they ship to various points in the coke region of Pennsylvania and West Virginia. They make a patent paving brick with a guttered top about one-third larger than the average sized brick, that appears to be meeting with some favor in the market. They make the Pompeian and other fashionable shaped buff-colored building brick.

The Dunbar Company obtains nearly all its clay from their mines, about two miles from the works, and about a mile southeast of Ferguson station, from which there is a tramway to two of the mines—the plastic clay. The flint clay is obtained from openings higher on the hill from which the clay is hauled in wagons to the tramway. The flint clay is obtained from two different beds; the upper bed, which is worked but very little, contains a thickness of only two or three feet of clay, and while it is of good quality, the bed is too thin to work with profit. The under bed which outcrops and is worked at a higher level on the hill, reaches a thickness of 14 feet in places, but it varies at close intervals, often a few yards, from a thickness of 14 feet to four or five feet. Both beds are said to furnish a highly refractory clay.

Mt. Braddock.—At Mt. Braddock station about two miles southwest of Dunbar, are the Eureka Fire Brick Works, which have been

operated by this company for 14 years. Previous to that time they were managed by a company known as the Mt. Braddock Fire Brick Co. They have a capacity of 12,000 bricks per day and manufacture coke oven, building and paving brick, the largest trade being in coke oven brick, their markets being mostly in the coke regions of southwest Pennsylvania.

The flint clay for the Mt. Braddock works comes from the hill about a mile and a quarter east of south of the works. The bed varies from four to six feet in thickness, sometimes a little less than four feet, and lies immediately underneath a heavy bed of sandstone. The clay has been mined from three different openings over an area of several acres. The one in which they are now working has been opened about two years and has undermined an acre or more. The clay contains some iron ore on the outcrop, but a short distance from the outcrop the iron almost entirely disappears and the clay is light colored and quite hard. It is taken by tramway to the works.

The plastic clay used by the Eureka Company comes from the mountain nearly two miles further south where it is said to occur in a bed about six feet thick. It is transported part of the distance by wagon and part by tramway.

Lemont Furnace (Darent Station, Southwest Pennsylvania Railroad).—The McClure Coke Co. have operated a fire-brick works at Lemont Furnace for 25 years. They make coke-oven brick exclusively, but by no means enough to build and keep in repair all their numerous ovens. The capacity of their works has been recently enlarged from 6,000 to 9,000 bricks per day.

They obtain some clay from the mines at Stewarton on the Youghio-gheny river, but the greater part of it comes from the hill about a mile southeast of the works. The clay is mined from a great many different openings on the hillside. The clay bed dips at about the same angle as the slope of the hill, so that while it does not outcrop it is in most places near the surface. It is quite irregular in thickness, varying in short distance from two to twelve feet or more. There is generally a foot or more of soft clay on top of the flint clay which in places almost entirely replaces the flint clay. The clay contains considerable iron ore.

White House (Wymp's Gap Postoffice).—D. H. Emme has mined fire-clay near White House (formerly called White Horse), in Fayette county, since 1868, but has only been shipping clay regularly for the last 12 years. At first the clay was hauled to the Monongahela river and shipped by boat. After the railroad was built he shipped from Fairchance, later from Smithfield, and now from Outcrop Station on the Baltimore and Ohio Railroad, about two and a half miles from the mines. The clay is used for making glass pots and is said to be

of superior quality for that purpose. The Pittsburgh Clay Pot Co., in Allegheny, probably the largest clay pot works in this country, use the clay from these mines. They state that it is better adapted to their purpose than any other clay they get in this State, and that they could use more of it if they could get it. The clay is obtained from open pits as the roof is too uncertain for it to be mined under cover. It occurs in a bed 12 to 15 feet thick, overlain by clay and coal. The following analysis shows it to be a clay of remarkable purity.

*Analysis of glass-pot clay from Wymp's Gap, Pa.**

	Per cent.
Loss on ignition,	11.94
Alumina Al_2O_3 ,	32.80
Silica SiO_2 ,	54.23
Oxide of iron,	0.21
Total,	99.18

Section in one of the openings at Emme's pot-clay mine, White House, Pa.

Soil, 5 feet.

Coal, with some shale, 4 feet.

Soft shale, 1.5 feet.

Hard shale, 4 feet.

Coal, 3 feet.

Blue clay with shale and iron stains, 10 feet.

Flint clay (pot clay), 10 to 15 feet.

The upper coal bed is said to be seven feet thick in places but is very slaty. The lower bed, known locally as the Kirk coal, has been mined for local use. The flint clay is a hard, clean looking, light gray colored clay, containing considerable iron on the outcrop.

IN THE MONONGAHELA VALLEY.

Fire brick works were found in only two places in the Monongahela river valley, viz: Manown and Courtney, at both of which places the material used is the gob from the coal mines. This is the "horse back" or clay parting that occurs in the Pittsburgh coal seam and is removed in the mining of the coal. The clay is about six to ten inches in thickness and while it would not be profitable to mine this clay alone, since it is removed as waste material along with the coal, it ought to be worked with profit.

For the best grade ware the clay is selected as it comes from the

*Made for The School of Mines in the Chemical Laboratory of The Pennsylvania State College.

mine, but in some of it all the gob, including the shale and other waste along with the clay is used. One might think that the clay from a seam six to ten inches thick would not supply much material for clay works, but some of these mines have been in operation many years and have undermined hundreds of acres of coal, and a seam of clay six inches thick spread over a hundred acres or more means a large quantity of clay.

The persistence of this clay seam throughout the entire area of the Pittsburgh coal bed is truly surprising. Over thousands of square miles this clay seam runs nearly uniform in thickness. What seems even more surprising is the same remarkable persistency of thin seams one-fourth to one-eighth of an inch in thickness. It is a wonder that more of this clay has not been utilized either for fire, building or paving brick, as there are vast quantities of it piled around the numerous mines over southwestern Pennsylvania.

Courtney.—John Tempest & Co. operate the fire-clay works at Courtney Station, on the Monongahela division of the Pennsylvania Railroad, about two miles below Monongahela City. The works are situated on the river bank near the station, and they use the gob or clay from the mine of the Mingo Gas Coal Co., the dump being close by the works. Mr. John Tempest is said to have started this industry of using the gob from the coal mine and invented his own machinery for handling and working the material. He says the machinery in the other works at Manown is modeled after his. They began operations at Courtney seven years ago and have had a prosperous business ever since. They operate eight kilns and have a capacity of 5,000 bricks or shapes per day. While they make some fire brick their principal trade is in sleeves, nozzles and steel runners for the large steel works. This use of fire-clay while newer than the brick industry is a large and rapidly increasing one, and this coal mine clay appears to be well adapted to the requirements of the steel trade. The principle markets are Pittsburgh and vicinity, Youngstown, Ohio, and eastern points.

They clay is worked much like other fire-clay. It is ground in dry pans, screened and mixed in the pug mill. The short pipes for steel runners are made differently from the somewhat similar looking drain-tile. Instead of coming from the machine in a continuous hollow tube and being cut by wires into proper lengths as with the tiling, it comes from the machine in a continuous solid clay bar about the diameter of the pipe. A piece about the right length is cut off by hand and fed by hand into a die in another machine, where it is stamped by a descending piston. As the piston rises the stamped piece is deftly removed by a workman and another piece of clay inserted, so that the process is a comparatively rapid one. The side hole in the pipe is cut by hand with a piece of tin spout thrust through a hole in a wooden form which fits over the pipe.

Watson Station (near Manown).—The Tempest Fire Brick Co. operates the works at Watson Station on the Pittsburgh, McKeesport and Youghiogheny Railroad, a short distance above Manown. The works were started about five years ago by the Watson Mine and Manufacturing Co., with Mr. Tempest, of Courtney, as manager. Later Mr. Laughlin superseded Mr. Tempest as manager. The works have been closed since about the first of this year (1897), and now (August) they expect to reopen in a few days as the Tempest Fire Brick Co., with Mr. John Tempest again in charge. They have 14 kilns and a capacity of 10,000 brick or shapes per day. They use the horseback clay or gob from the coal mine. As at Courtney, the principal trade is in steel runners, shapes and nozzles for the steel works, but fire bricks are made on demand.

Manown, Pa.—The Manown Manufacturing Co. (main office Lewis Block, Pittsburgh), operate a fire brick works at Manown, on the east side of the Monongahela river, about two miles above Monongahela City. Mr. Jenkins is the superintendent. They have been in operation two years and, like the Watson and Courtney works, the chief trade is in pipe shapes for open hearth and Bessemer steel works. They also make fire brick and ground fire-clay. They have eight kilns and a capacity of from 2,000 to 5,000 shapes per day, depending on the size. They use the clay from the parting in the Pittsburgh coal bed as it comes from the dump of the Youghiogheny Coal and Gas Co. The clay seam is about eight inches thick, but as the mine has been in operation many years, there is a large supply of it on hand.

They ship a great many pipe shapes for the steel works to Alabama, but their principal trade is in Pennsylvania and Ohio.

CHAPTER VI.

RED AND BUFF BUILDING BRICK.

Building brick clays.

Composition.

Physical properties.

Varieties.

Shales.

Classification of building brick.

Buff brick.

Spotted brick.

Vitrified brick for building.

Machinery and methods for making brick.

Paving brick.

As the brick clays are so widely distributed, so common, so well known, and the price of the brick so low, the value and extent of the

common brick industry is frequently overlooked particularly by the manufacturers of the high priced stock. Despite the little attention that is given to the subject the aggregate value of the red bricks produced is greater than that of any other single clay product in the State or in the United States, and it will no doubt continue so because of the great numbers of producers and the vast quantities produced. It is likewise an industry that should be encouraged as the use of bricks in place of wood is to be commended in the towns from the standpoint of safety if not of architectural beauty. From the latter standpoint brick, especially common red brick, are inferior to first class stone and in the finer and more expensive structures they can not hope to compete with the stone, but in the cheaper business houses and dwellings they can be and are used extensively, while the buff and variegated bricks and the finer grades of red brick and terra cotta are coming into very active competition with stone in the most expensive buildings.

Building-brick clays and shales.—The clays used in making building brick have an exceedingly wide range in composition, color, texture and origin. Those used in making the buff or light colored bricks come under the general term fire-clays. Red-brick clays are widely distributed and occur as alluvial deposits along the streams, or as soils from decayed shales, limestones, sandstones or other rock, or from a mixture of two or more of these. In certain localities the clays may be a glacial deposit, and in some localities loess. In the region covered in this report, only the first two classes are used if we include in the alluvial deposits the terrace clays used so abundantly about Pittsburgh and elsewhere along the rivers. In recent years shales of different kinds have been used extensively for making building brick. The use of shale probably began in the manufacture of paving brick and from that extended to the building brick industry.

So many grades and kinds of material are used for making brick that it is sometimes thought that anything which has sufficient plasticity to be molded will do, which in part is true. Almost any soil or rock that one can find, except the nearly pure sand, can be molded and burnt into brick, but it is not true that they will all make equally good bricks, in fact many will make quite inferior bricks and many have been used for this purpose which should not have been used. Some of the necessary conditions for good brick clay are:

1. Proper Composition.—While good brick material may have a wide range in composition it is not indefinite by any means. It should not be too rich or fat, that is the percentage of alumina should not be too great or the shrinkage will be excessive, and the brick will crack and craze in the drying and burning. The extremes are given in the table below by Wheeler. This defect may be and often is remedied by mixing sand or other material with the clay. Sand is the chief

foreign constituent in the clay and ranges from 20 to 60 per cent. It prevents cracking and excess shrinkage. If not in sufficient quantities naturally it can be added artificially in the grinding and mixing of the material.

The alkalis, lime, iron and magnesia are the fluxing constituents, but in red brick may have a wide range if proper precautions are used in burning. If red bricks are desired there must be a sufficient amount of iron present, not less than two or three per cent., but the percentage allowable depends partly on the manner in which it is diffused. The color may also depend upon the chemical condition in which the iron exists in the clay, combined with the manner of burning. It may also be governed partly by the other constituents. Thus lime may neutralize in part the color of the iron as in the Milwaukee brick.

Range in Chemical Composition of brick clays.

Constituents.	Average per cent.	Minimum per cent.	Maximum per cent.
Silica, combined,	15.0	12.0	30.0
Silica (sand),	55.0	20.0	60.0
Alumina,	14.0	11.0	25.0
Water, combined,	4.0	3.0	9.0
Water, moisture,	2.0	0.0	6.0
Iron sesquioxide,	4.0	2.5	8.0
Lime,	1.5	0.5	7.0
Magnesia,	1.0	0.3	8.0
Alkalis,	3.5	2.0	7.0

2. Physical properties.—The plasticity of clay is determined largely by the amount of amorphous clay base or kaolin present. If this is in excess the clay may become “fat” and the shrinkage in the drying and burning become so great as to crack or craze to the injury of the brick. If the clay base is too low the clays will crack or rag in the molding and form brick of low tensile strength. The total shrinkage in the drying of the brick may vary from 4 to 20 per cent., in the burning from 2 to 8. The total average shrinkage is about 10 per cent.

As the proportion of fluxing impurities is high, generally 8 to 10 per cent., the bricks fuse easily compared with fire bricks, but they are rarely burnt at a temperature high enough to fuse them, hence a high percentage of fluxes may not be really injurious so far as the fusing is concerned, but some of the fluxes may be injurious in other ways. A high percentage of lime or even a low percentage if in lumps will weaken the brick, as in the burning it will be changed to quick-lime which will slake and crumble to powder in the brick. The lime and magnesia will sometimes react on the iron greatly marring or destroying the color.

The red color of the common brick is due to iron. In the yellow clays the iron exists mostly as hydrous oxide or limonite, in the blue clays it may occur as the carbonate or sulphide or silicate or all of these. In the burning the water is driven off in part and the lower or ferrous oxide changed to the higher red ferric oxide. The color depends upon (1) the amount of iron present, (2) the manner in which it is diffused, (3) the temperature at which the bricks are burned, (4) the character of the fire whether reducing or oxidizing and (5) the relative percentage and diffusion of lime and magnesia.

Varieties of brick clays.—All the brick clays might be classified geologically on a basis of origin and mode of occurrence into (1) Residual clays, (2) Alluvial clays or stream deposits, including terrace clays, (3) glacial clays, (4) Loess clays, (5) beds interstratified with other rocks and (6) shales. Of these classes the fourth is not known to occur in Pennsylvania, but is of great value at many places in the Mississippi valley. The third does not occur in the area under discussion in western Pennsylvania, if we except the river terrace deposits, but they are quite important in many localities in northwestern and northeastern Pennsylvania, and all over northern United States. The first two classes are most widely distributed and furnish the bulk of the material for common red brick.

The residual clays are the surface clays found as soil coatings of varying depths in almost every locality and covering nearly all classes of rocks. There are few soils except the very sandy ones that do not have sufficient clay to make bricks. Nearly all the surface clays away from the immediate vicinity of the streams in central, southern and western Pennsylvania belong to this class.

The alluvial clays are deposits found along all large streams and many small stream courses, forming the river and creek bottoms and terraces. In some places this material is too sandy to make good brick, but in many places the sand and clay are in the right proportion for brick, and as the material needs no preliminary grinding, but may be thrown at once into the pug mill, it furnishes a cheap and abundant brick material.

The terraces bordering all the rivers of western Pennsylvania and their tributaries furnish large quantities of excellent brick clay, some of which is even utilized for pottery ware. A river terrace is a comparatively level platform or bench generally covered with a variable thickness of sediment deposited when the water stood at or near the height of the terrace. Some of these deposits are more than 200 feet above the present river level, and in some localities no less than four of these terraces can be clearly located. Like the river deposits now being formed, they are made up of sand, clay and boulders in varying proportions and in many places the material is of excellent quality for making red brick. In chapter VIII may be noticed the large num-

ber of brick yards in Pittsburgh and vicinity that use these terrace clays.

Beds of clay occur interstratified with the other rocks similar to the fire-clays, and if they happen to be blue or gray in color, are called fire-clay. Some of them furnish excellent material for red brick.

Shales differ from common clay in being laminated or fissile, and indurated or hardened, and generally contain more sand and foreign material. They cannot, like alluvial or terrace clay, be tempered and molded without previous grinding. They should be thoroughly ground either in rolls or pans and even then are not as plastic as many clays. Shales were and still are used extensively for making vitrified paving brick. Their excellence in making paving brick together with the improvements in machinery for grinding and handling the material probably led to the more extended usage of shales in making building brick.

Classification of building brick.—Bricks are variously classified on different bases. The common red brick are divided into common or backing brick and stock or face brick; these may be further subdivided into several grades, based on hardness or color. *Soft or salmon brick*, embracing those not hard enough for outside walls, includes such commercial varieties as soft, salmon, backing-up, pale, light, chimney, filling-in, inside-wall and foundry brick. *Stock brick*, embracing all hard enough for outside walls, may be divided into hard, common building, paving, hard building, outside, hard red, strictly hard, select hard, rough hard, hard washed, kiln-run hard, and common hard brick. The stock brick may be made from the same clay and burned in the same kiln as the common brick, but are made, handled and sorted with greater care and hence command a better price. The size of a common brick is about $8\frac{1}{2}$ by $4\frac{1}{4}$ by $2\frac{1}{4}$ inches, but it may vary a quarter inch or more in length, depending on how hard it is burnt. The standard size brick adopted by the National Brick Makers' Association of Builders and the American Institute of Architects is $2\frac{1}{4}$ by $4\frac{1}{8}$ by $8\frac{1}{4}$ inches, and the standard size press brick one-eighth of an inch thicker but the same size otherwise. This has not been universally adopted; in many localities there is a variation of one-eighth to one-half inch from these dimensions. It would certainly be desirable from many standpoints to have a standard size for the United States, but it seems difficult to get every one to agree to it.

In fancy or ornamental brick other sizes are now used in large quantities, the most common of which is the Roman or Pompeian brick, about 12 by 4 by $1\frac{1}{2}$ inches, the size used in Pompeii and in many of the old Roman buildings. This size is now quite common in costly buildings, especially in buff colors and makes an attractive front where properly used. They are laid on the flat side and backed up



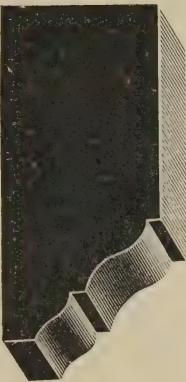
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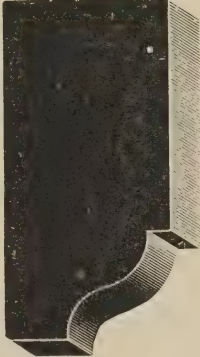
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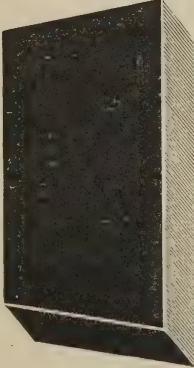
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Fig. 25. Showing some of the common shapes of ornamental bricks.

with common brick. The Norman is another size not quite so common as the Roman.

Ornamental bricks for cornices, trimmings, etc., are made of a great many shapes, sizes and colors. The accompanying illustration, fig. 25, shows some of the many forms used. There is practically no limit to the number of designs and shapes and the architect is given a wide range in this line. The ornamental bricks are either dry-pressed or re-pressed. As a rule they are not made by the small operators, because it requires costly machinery, good clay, and considerable skill often gained by rather expensive experiments to make ornamental brick successfully. The ornamental red brick made in Western Pennsylvania are inconsiderable in number. The following companies make ornamental, buff and variegated brick: The Kittanning Brick and Fire Clay Co.; The Kittanning Clay Manufacturing Co.; The Fallston Fire Clay Co.; Welch, Gloninger & Co.; The Layton Fire Clay Co.; The Dunbar Fire Brick Co., and Hiram Swank's Sons. Reese, Hammond & Co. expect to be manufacturing all grades of building brick before this is published.

Enameled brick, while not manufactured in commercial quantities in western Pennsylvania at present, have been made in small quantities and much costly experimenting has been done in that line without decided success. It requires a high degree of technical skill to make enameled brick successfully. They are made in eastern Pennsylvania and elsewhere in the United States, and it is only a question of time until they will be made in quantity in western Pennsylvania.

Buff brick—Buff colored brick have been known in the market for many years but it has only been a few years since their architectural beauty and possibilities have been fully recognized and as a result their manufacture and use have increased at a remarkable rate within quite recent years, and they are now being used in large quantities, especially in our eastern cities. So far as known to the writer the first buff bricks made in the United States were made in Milwaukee and for many years Milwaukee brick and buff or light-colored brick were synonymous terms, but it is now no longer the case.

A large part of the buff brick manufactured in western Pennsylvania is shipped east. This is partly due possibly to the fact that buff brick are manufactured in greater quantities in the Mississippi valley than in the eastern states and partly due to the fact that architecture is further advanced in the eastern states than in the western states and there is a greater demand for attractive, even though more costly material. The light-colored bricks are replacing stone to some extent in the finer grade buildings.

When we consider the various shades, forms and styles of bricks we can readily see how well they are adapted to the wants of the archi-

tect, and we can hope for architectural improvements in their more extended usage.

Manganese or spotted brick.—It is sometimes desirable for architectural reasons to break a light or uniform color by other than the common red brick and one way in which it is done is by using the oxide of manganese, which is black, but sprinkled through a buff brick it may produce gray of various shades, depending on the amount used. If the manganese is used in grains or particles of considerable size, it will form dark spots in the light brick and may even give a granular appearance not unlike some granitic rocks. The variety obtainable in grain and shading, not only in the buff but in the red brick as well, by the use of manganese is very great and the brick makers are using larger quantities of it each year. Different shades of brown may be produced by mixing manganese with the red clay.* It is also used as a coloring matter for brown mortar in laying the brick.

Waterproof or vitrified brick.—Many of the buff bricks are now burnt much harder than the common building brick, not entirely to the vitrifying or glassy stage, as the name would signify, but rather an incipient vitrification more like stone than glass and which might be called lithification. These are in no way different from the vitrified paving brick, except that generally a little more care is taken in the manufacture to secure smooth surface, sharp corners and uniformity of size and color.

They have their origin in the vitrified paving brick, which no doubt suggested to builders the advantages of a vitrified brick for buildings. The advantages claimed for them are that they do not absorb water, hence form a dry wall and do not permit the vegetable growth that often disfigures and disintegrates brick walls; for the same reason dirt and dust do not collect on their surfaces so readily, hence they are much cleaner than porous bricks. The white efflorescence commonly known as saltpeter or whitewash, if it can be prevented in the drying and burning is almost if not entirely prohibited, as there is no opportunity for a solution to work through the brick, hence no chance for the efflorescence to form on the surface by weathering. They are stronger than common brick. All these qualities combine to give them an architectural value.

Rain brick.—A unique form of brick which has had a limited use in some of the western states is the rough face or rain brick. When the bricks were dried in the sun on the open drying floor, it sometimes

*Manganese is produced in Virginia, Georgia and Arkansas and small quantities in other states. Much of it is used in making steel. Its use in brick manufacture is comparatively new but rapidly increasing in use. Much of that used in Pennsylvania comes from Virginia, and is prepared for this purpose by a company in Washington, D. C., who make a specialty of manganese for brick and mortars.

happened that a sudden shower of rain would fall on the green bricks before they could be covered, thus producing a roughened or rain print surface. These were burnt and sold at a lower price until some enterprising architect found that they added to the beauty of a building when judiciously mingled with the smooth-faced bricks. Rain bricks were then in demand and the price advanced beyond that of the smooth brick. When it did not rain often enough to supply the demand artificial rain was produced with a hose. The writer has not observed that these ever became popular in Pennsylvania.

Hollow brick.—Hollow brick are generally much larger than common brick, and as the name indicates, they are hollow. Sometimes they have a simple rectangular cross section, sometimes there are one or two partitions making two or four rectangular divisions in cross sections. The advantages claimed are that the bricks can be made much larger without undue weight; an economy both of material and weight without sacrificing strength. They are now made with great variety of surface ornamentation and coloring, and may be made to give the effect of stone work where the face is roughened (which is now done in the molds) and properly colored. The cheaper, plainer forms are used in some localities for foundations, for retaining walls, for stables and even houses and store buildings. They have an extensive use in many of the Mississippi valley states, but are not manufactured or used to any noticeable extent in western Pennsylvania.

Terra cotta lumber and fire-proofing resemble in some respects the hollow brick, but they differ in that they are made porous and open in texture in order to give them light weight for use in floors and partitions in large buildings. They are hollow and can be bound by rods or bands of steel, or may furnish openings for the passage of gas pipes, electric wires, etc. The porosity is obtained by mixing sawdust in the clay, which is burnt out in burning the brick, thus leaving cavities in place of the sawdust grains. The use of this material is increasing as a substitute for wood in floors and partitions in fire-proof buildings. The only factory of this material known to the writer in western Pennsylvania is the Pittsburgh Terra Cotta Lumber Co., in Pittsburgh, which is described in chapter VIII.

MACHINERY AND METHODS OF WORKING CLAY AND MANUFACTURING BRICK.

It has not been many years since all the common red brick were made from surface clay, tempered in the common upright pug-mill operated by horse power, molded by hand, dried in the sun, and burnt in the rectangular up-draft kilns with three stationary walls, and one

temporary one, that is removed after the burning. A very small percentage of the brick are so made in eastern United States to-day. The upright, wooden, horse-power pug-mill and the open drying floor that could be used only two or three months in the year are now almost as much of a curiosity as the once common spinning wheel.

Methods of mining and handling the clay.—The several methods of mining are:

1. Digging by hand entirely from the base of the bank and transporting by wheelbarrow or cart.

2. To loosen the clay by plows and bring it on a road scraper.

3. Working in benches, where the clay is 30 feet or more in thickness. It is often desirable to work it on three or more benches.

4. Steam shovels are sometimes used (see Booth and Flinn, chap. VIII).

5. Undermining by wedging.

6. Blasting is often needed in shales and the harder clays.

7. It is sometimes mined in pits.

8. Where the clay has a heavy covering, as have many of the fire-clays, galleries and drifts are run in as in the coal mines.

9. A belt is sometimes used as a conveyor either to move the clay from the mine or from the storage clay. Tram cars of different types are in common usage. The old method was to dig by hand and transport to the pug mill by wheelbarrow. In some of the small yards this plan is still followed; in some the horse and cart have replaced the wheelbarrow, but in most of the larger plants the clay is loaded on tram cars which are run into the works by horsepower, or by a locomotive or stationary engine. In one of the largest brickworks in western Pennsylvania (Booth and Flinn's) the clay is loaded on the tram cars with a steam shovel. The same company also uses a train of self-dumping cars, which combined with the steam shovel enables them to handle clay very rapidly. See fig. 43. Sometimes the clay is carried to the mill on a traveling belt. See fig. 29. In the works of the Cambria Iron Co., at Johnstown, the clay is carried from the storage shed to the machine by a belt.

Grinding and tempering.—Different methods are employed for grinding and tempering the clay. One of the most primitive methods is to tramp it with cattle or horses, a process it is hardly necessary to state that is not in vogue in this State. The most primitive method in use in Pennsylvania is the upright wooden pug mill, run by one horse. Another allied method is that in which a large wheel is put on a long shaft, one end of which is held by a vertical pin in the centre of the clay to be mixed; to the other end is attached a horse which travels in a circle about the clay dragging the wheel through it. This process proves to be a very effective, but very slow, one with certain grades of clay.

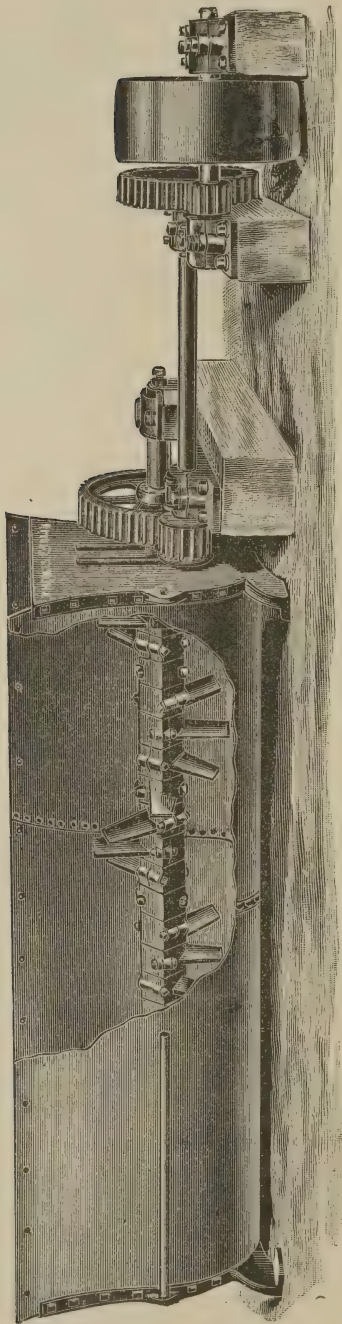


Fig. 26. Horizontal pug mill.

Where the clay is of such a character that it can be mixed without previous grinding, the horizontal steam power pug mill is most commonly used. These are of numerous sizes and varieties but all work on the same principle. Fig. 26 shows a typical form of the horizontal pug mill.

Much of the clay and all of the shale used in brick-making is first ground before tempering, which may be done in a wet pan (see fig. 19, but may be done in a dry pan (see fig. 20), or by a roller or crushing machine, of which there are numerous types. The very hard material is sometimes first put through a common rock crusher before it is put into the dry pan or disintegrator. After grinding, the clay is elevated and screened as with the fire-clay and is then tempered in the pug mill which may form part of the molding machine or may be separate.

Molding the bricks.—The old method, which is still in use for making fire brick, but is now abandoned for making building brick, except in the small or temporary yards or for intricate shapes, was to mold by hand. The machines are rapidly displacing all the hand-workers because of the greater cheapness with which brick can be produced, and the improved quality of the brick at least for certain purposes. The average day's work for a molder and two off-bearers is 4,000 bricks (in some places 3,000)* while a brick machine will turn out 15,000 to 100,000 or more, depending upon the size and make of the machine.

One of the first brick machines of which I find any account in this country was made in Philadelphia in 1840. It was a soft clay machine operated by horse power, and was destroyed in a riot by brick-makers seven years later, on the plea that it would take bread from the mouths of the workmen. In the same year (1847) a dry clay machine was made in Philadelphia.†

Nathaniel Adams, of Cornwall, N. Y., is said‡ to have taken out a patent for a brick machine between the years 1830 and 1840, one type of which is said to be still in use.

It has been within comparatively recent times, in fact within the last 20 years, that most of the brick of this country have been molded by machinery.

The many different kinds of brick-molding machines are divided into two classes; the soft-mud and the stiff-mud machines. The soft-

*In 1832, in Cincinnati, the molding of 9,000 bricks was a regular day's work. In a contest between two expert molders, working from sunrise to sunset, one made 24,700, the other 25,470. The results were about the same at a similar contest in Philadelphia at a later date.—Trans. Civ. Eng., Vol. 25, p. 362.

†Trans. Civ. Eng., Vol. 25, page 362.

‡Brick, Chicago, Dec., 1897, Vol. VII, No. 6, p. 225.

mud machine more nearly resembles hand-molding than the stiff-mud. The clay is forced into molds similar to the hand molds and the top surface scraped by the machine, thus making a brick with one rough face. The number of bricks molded at a time varies with the size of the machine. One molding six at a time is quite common. The molds are removed and empty ones put in by the off-bearers. Fig. 27 shows one type of soft-mud machine used quite extensively in western Pennsylvania. It is manufactured at Lancaster in this State, and has been in use since 1858, but there have been several improvements since it was first put on the market.

The stiff-mud auger machines are of many sizes and styles. The main feature of all is that the clay is forced out through a die in a continuous bar which is cut by wires into the sizes desired. The bar of clay may be of any size desired and the cutting may be done in different ways. It is generally done by wires, and may be either by hand or automatic. The hand-cutting machines (fig. 28) may cut any number of bricks at a time, depending upon the size of the table and the number of wires. Twelve is a common number, but sometimes as many as 18 are cut at once. The bricks are delivered on a board which is removed by the workman and another put in its place. The bricks may be side cut, end cut, or edge cut, the first being the most common with hand-cutting machines, the second the most common with the automatic.

The same machine may be changed from a side-cutting to an end-cutting by changing the size of the bar of clay which is done by changing the die on the end of the machine. Sometimes two or more bars of clay may be delivered at once and the capacity of such a machine is only limited by the amount of clay that can be fed into it. Figure 29 shows the action of an automatic end-cutting brick machine. In most of the more modern plants the bricks instead of being loaded on a wheelbarrow, as shown in the illustration, are loaded on an iron car, which is then run into the drying tunnels. Not only the common-sized brick, but those of any desired size, even hollow brick and tiling may be made on a machine of this kind by simply changing the die through which the clay is forced. There is scarcely any limit to the variety of products that may be made on a machine of this kind. The molding machine and pug mill may be combined in one or may be separate. While a great many different machines are used in western Pennsylvania, the most common soft-mud machine is the Henry Martin machine, made in Lancaster, Pa., and the most common side-cut, stiff-mud machine is the Freese, made in Gallion, Ohio.

There is another type of stiff-mud machine that differs from the auger machine in forcing the clay through the die by a stroke of the piston and consequently the flow of the bar of clay is intermittent instead of a continuous stream as in the auger machine. No ma-

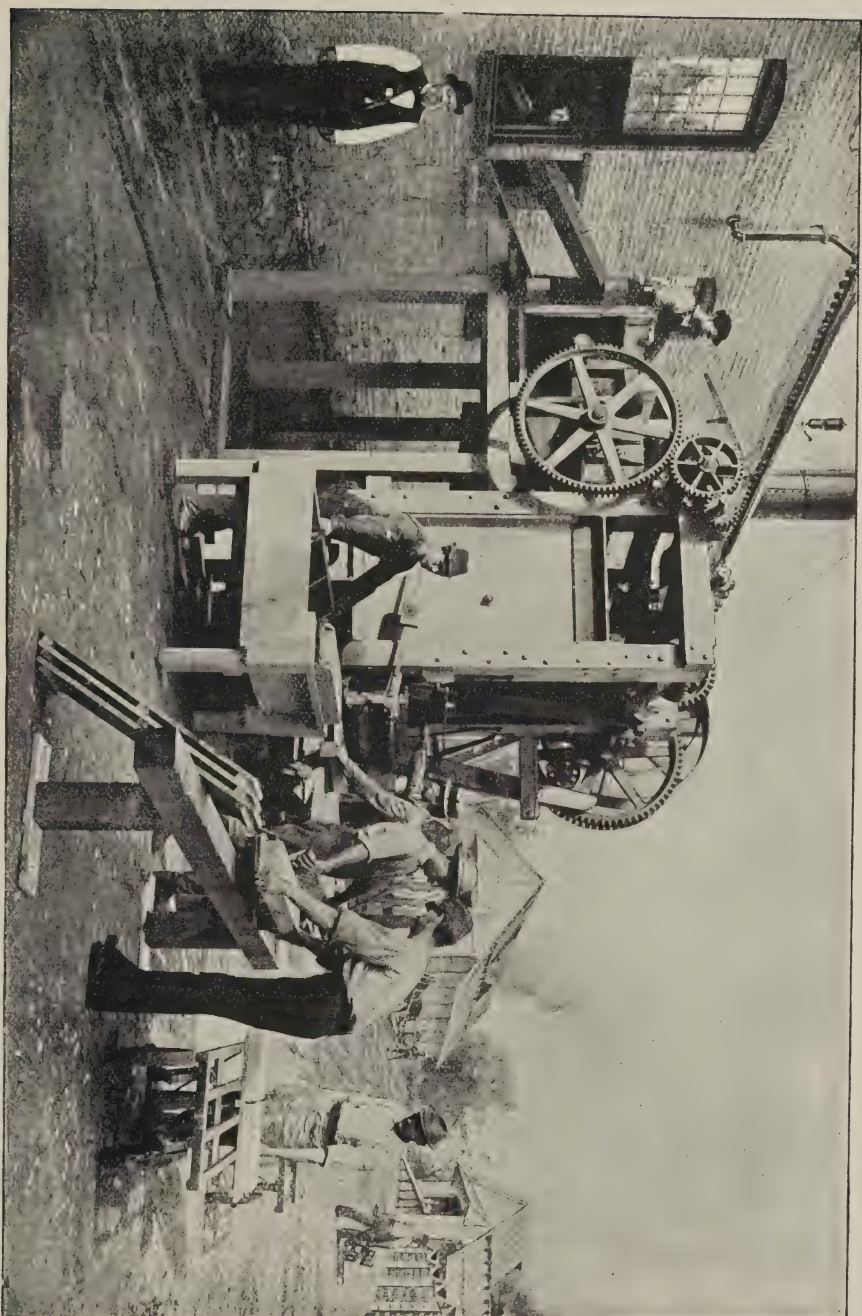


Fig. 27. View of soft-mud brick molding machine, clay elevator and pug mill at work.

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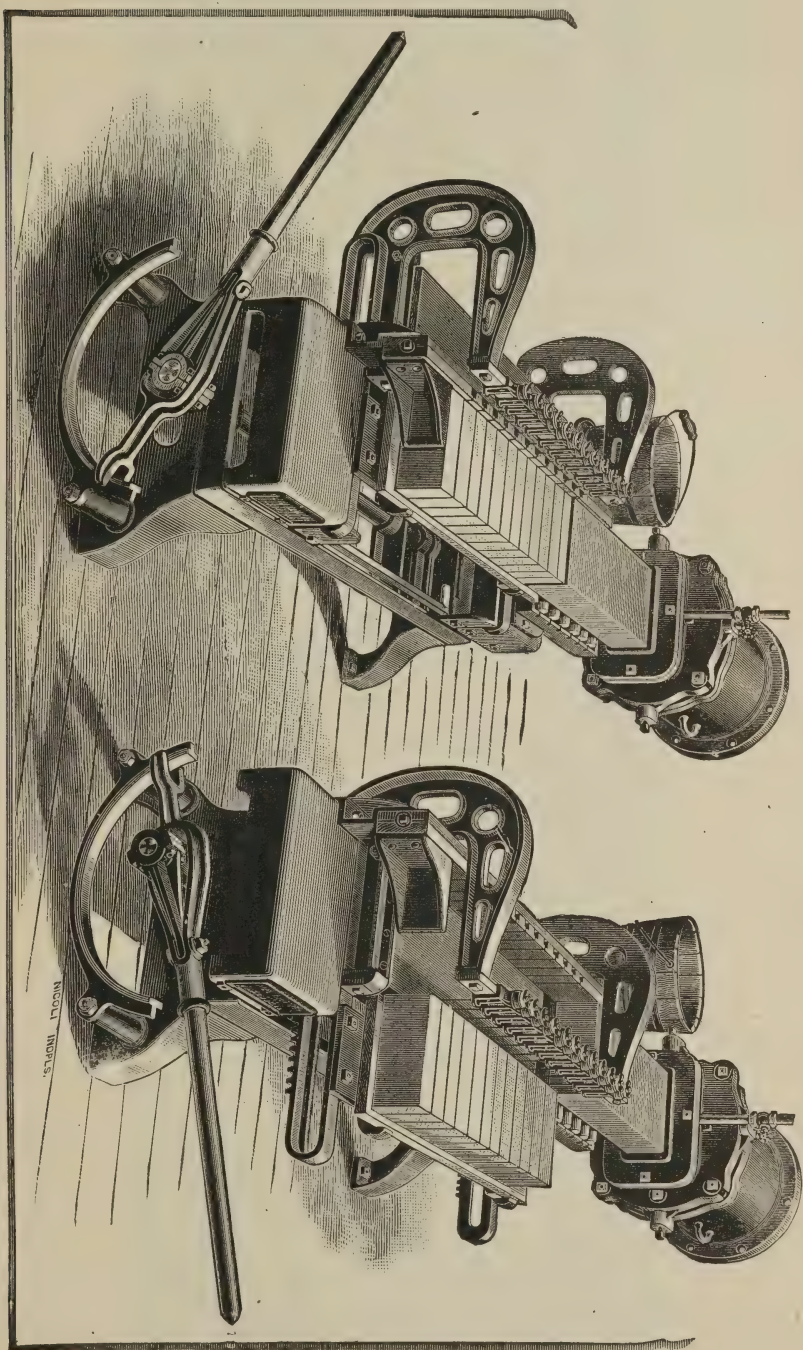


Fig. 28. Two views, hand-cutting, stiff-mud, improved pattern, board delivery brick molding machine.

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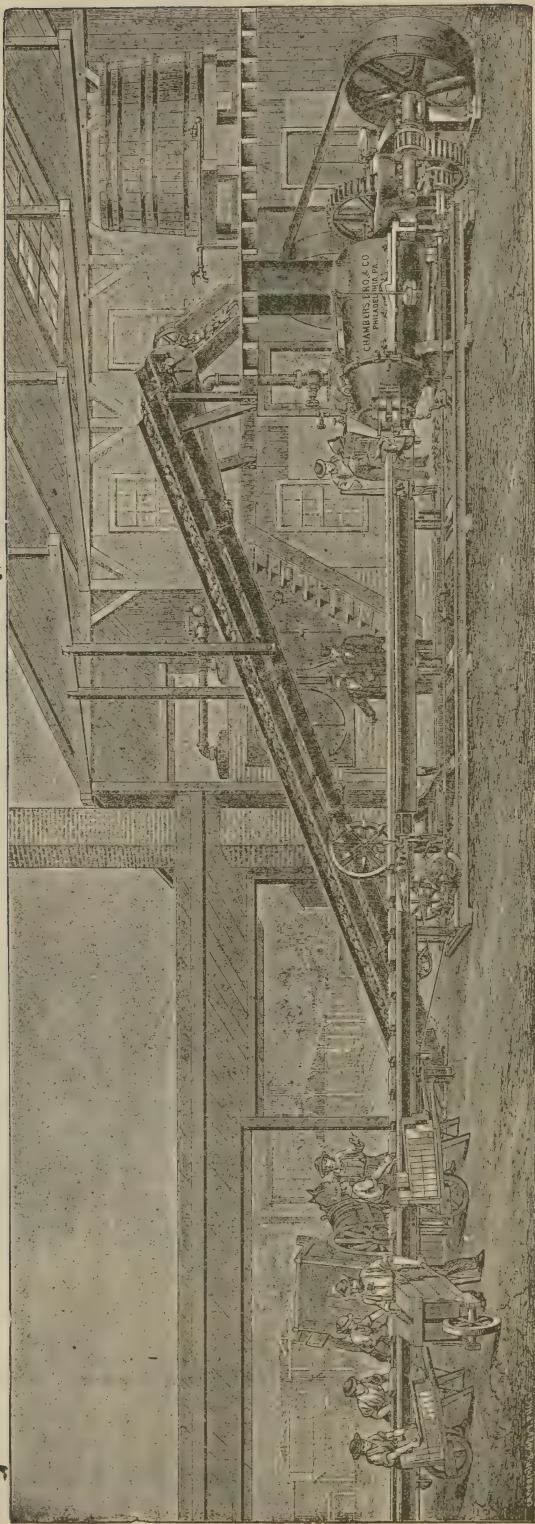


Fig. 29. An automatic, stiff-mud, wire-cut, brick molding machine at work.

chines of this type were observed in the factories in western Pennsylvania, although they are said to be quite common in Ohio.

An attempt at a combination of these two types has been tried in at least two different machines described by Prof. Orton in his report on the clay industries of Ohio.* None of these were observed in western Pennsylvania.

Repressing.—Whether molded by hand or machine the clay that is plastic enough to mold easily is subject to mishaps, as in handling the corners and edges will be crumbled. If not always kept on a level surface it will warp or bend in the drying and all machine-made bricks will have at least one if not two rough surfaces. To remedy these defects and produce a more regular smooth and shapely brick,

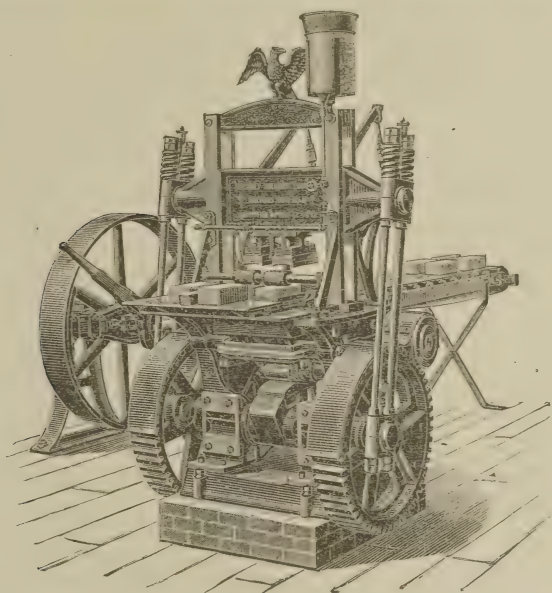


Fig. 30. Steam-power, brick, repressing machine.

they are re-pressed either by hand or steam power. This extra handling of the brick is expensive and of course increases the price of the brick, as it increases the quality. The process is not essentially different from that in the fire-brick works (see fig 22). The re-pressed bricks are denser and supposed to be stronger than those not re-pressed.

Dry press.—Some bricks are made in manner similar to that used in making tile, in which the clay instead of being mixed into a plastic mass with water is molded dry or with only sufficient moisture to cause the dust to cohere when pressed in the mold. This process makes a very dense brick with smooth even surfaces, very desirable

*Geol. Surv. of Ohio, Vol. VII, p. 161.

for many architectural purposes. They can be taken directly to the burning kiln from the machine without the intermediate drying. In spite of this, however, the process is more expensive.

Drying.—The old method of drying was to spread the bricks out in the sun on a level area. This process has now been abandoned by all but a few small yards which operate only at rare intervals. The next stage was to put a covering over the drying floor to protect the bricks from the rainfall and then heat the floor artificially. This is in use yet in many places. Another advance following the use of the improved machinery is the tunnel dryer. These are of different types; in some the tunnels are heated by fires built underneath the track, as at the yard of the Cambria Iron Co. Sometimes the tunnel is heated by steam pipes, sometimes by hot air. In the progressive tunnels, the cars are run in at one end and when the next car is put in it is pushed forward a car length and is thus moved slowly to the other end of the tunnel, the rate being so regulated that the bricks are dry enough to stack in the burning kiln when they reach the far end of the drying tunnel. Figure 31 shows such a tunnel. At the extreme right a car loaded with green brick may be seen entering the tunnel; at the left a car of dried brick has just emerged on its way to the kilns.

Burning.—After the bricks are dried they are stacked in the kilns and burnt, which is the final stage of manufacture. The different fuels used are wood, coal, natural gas and petroleum. There are now many different types of kilns in use. A few years ago all the red brick were burned in the common, rectangular up-draft kiln which had three permanent walls, the third being removable, the heat coming from fires built at the bottom and winding its way up through the bricks, escaping at the top. In the down-draft kilns the gases are drawn off at the bottom of the kiln and find their way to an outside chimney. Sometimes one stack will serve for four or more kilns. Many of the down-draft kilns are circular in outline, but some are rectangular. There are many patent kilns in this class all claiming some special improvements. The continuous kiln is used in a few places and will no doubt be used more extensively in the future when its merits are fully known and appreciated, and its manipulation is better understood.

Booth and Flinn, and Harbison and Walker, at Pittsburgh, and Welch, Gloninger & Co., at Monaca, each use the continuous kiln. The Westmoreland Fire Brick Co., at Hunker's Station, have one in their works, but it has not been used for several years.

The accompanying illustration (Fig. 32) shows the plan of a modern brick plant, giving the relative position of the machinery, kilns, dryer, etc.

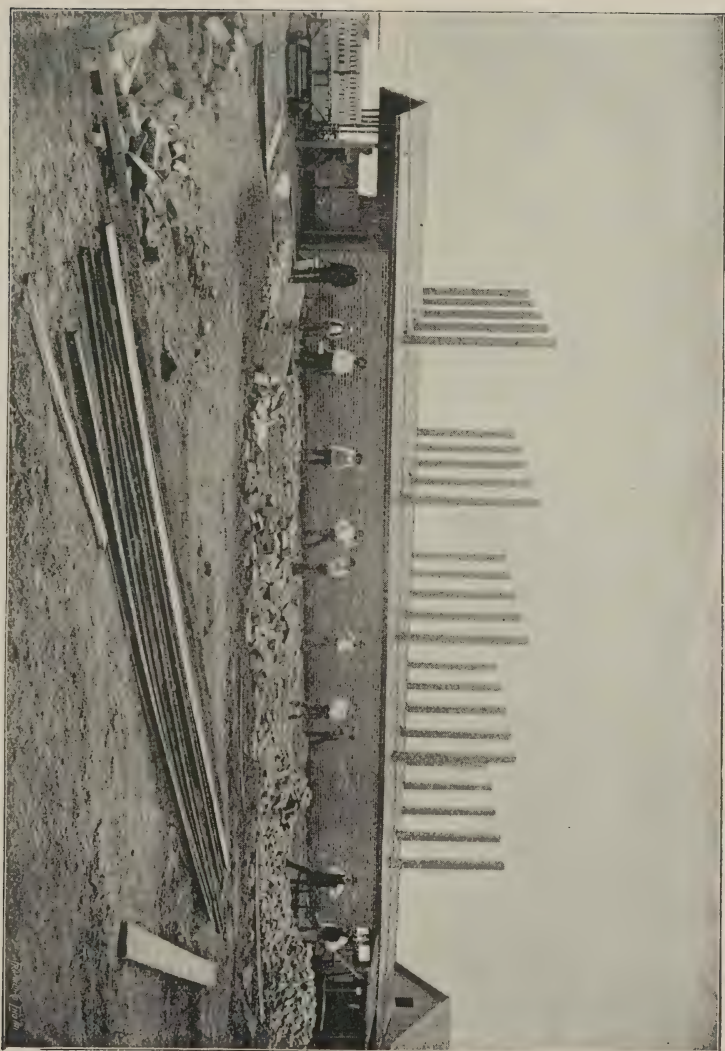
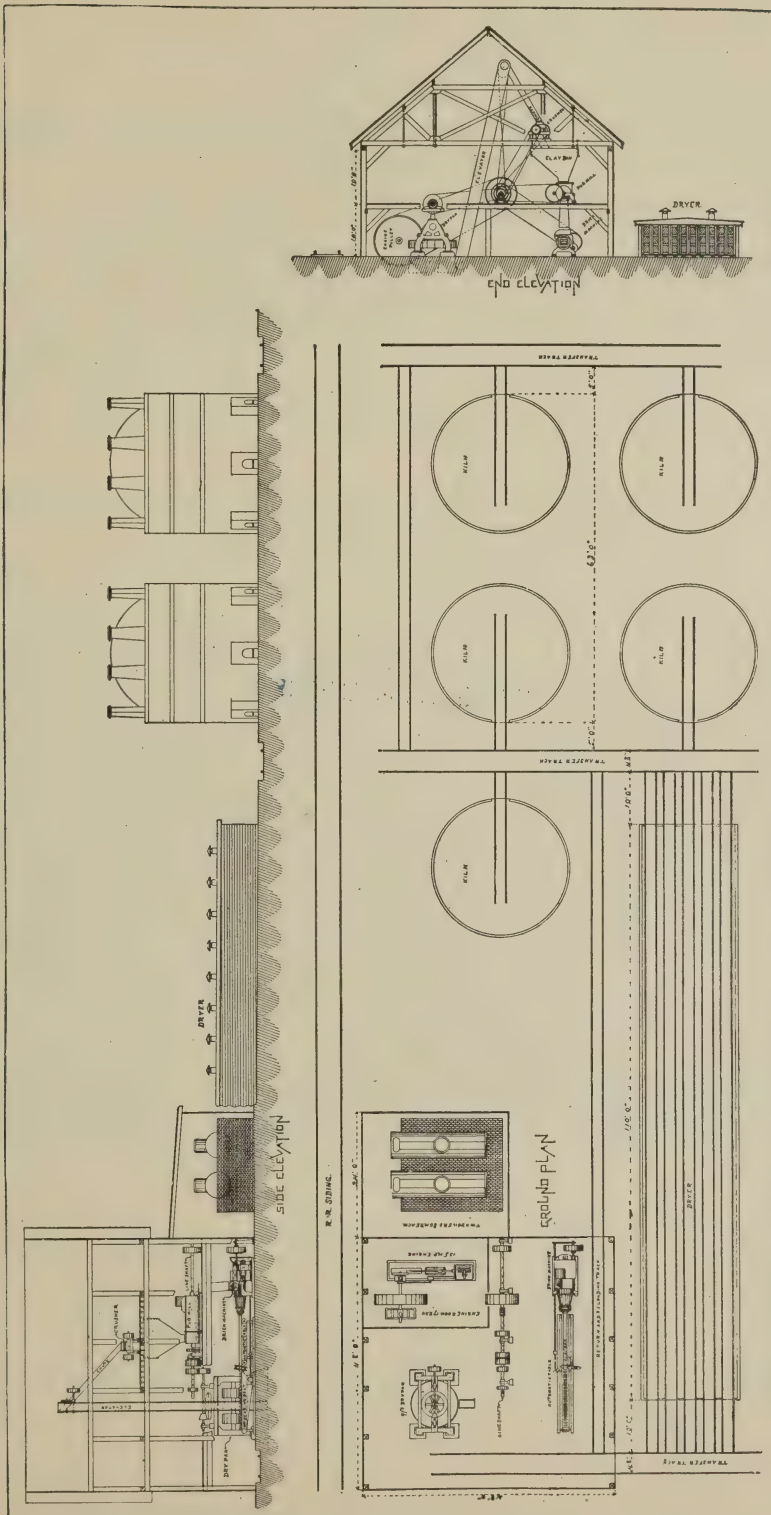


Fig. 31. The progressive Bucyrus drying tunnel.

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F.g. 32. Plan and elevation of a modern brick-making plant.

CHAPTER VII.

RED AND BUFF BUILDING BRICK INDUSTRY IN WESTERN PENNSYLVANIA.

A considerable number of the brick companies mentioned on the accompanying table are small and do a strictly local business, sometimes supplying the home market entirely, sometimes only in part. A number of them ship brick to neighboring towns and several who make the finer grade bricks ship to other states. The manufacture of common red building brick reaches its maximum importance in Allegheny county, as shown in the following chapter. High grade building brick are made at Kittanning, Fallston, Vanport, Layton and Bolivar.

Ohio and Beaver Valley brick works.—The Ohio valley works in Allegheny county are described in Chapter VIII.

There is a small brick yard on the river bank at the upper end of Rochester, where common red building brick are manufactured to partially supply the local demand. The bricks are made from the alluvium of the river bank and burnt in the common, open-topped, up-draft kilns.

The two large brick works at Monaca across the river from Rochester, manufacture some building brick, but only as side issues (see fire brick and paving brick).

The Vanport Brick Co., at Vanport, Pa., have manufactured large quantities of building brick. At the time of my visit, September, 1897, the works were idle, owing to some financial troubles in the company. The works have been in operation for about 30 years. They were first operated by Mr. S. R. Mitchell, who was followed by Mr. John Russell. The Vanport Fire Clay Co. was in possession from 1881 to 1897. The works are now, 1898, operated by the Vanport Brick Co., who make a nice grade of building brick and have a capacity of about 20,000 per day. The bricks are machine made in a stiff-mud wire-cut machine, using both hand and steam re-press machines. The bricks are dried on the ear in a hot-air drying room and burnt in five round down-draft kilns. Pittsburgh and the neighboring towns form the chief market. The bulk of the clay used was taken from the bed of Lower Kittanning fire-clay on the bluff at the works. It has a workable thickness of from 10 to 12 feet. The fire-clay is overlain by about 20 inches of coal and 15 feet or more of soft yellow shale. Some of the shale is mixed with the clay when red bricks are desired, as the clay alone burns a light color. The terrace clay at the works has been used to some extent for the same purpose as the shale, namely, to color the brick.

Welch, Gloninger and Co's works, immediately adjoining those of the Vanport Brick Co., manufactures some building brick from the same kind of materials, but their chief trade is in fire brick, the building brick being a side issue. (See p. 68.)

The Fallston Fire Clay Co., near Fallston, in the Beaver valley, is one of the prosperous manufacturers of high grade building brick. They make some fire brick and paving brick, but their chief business is high class buff building brick of different shades and forms. They manufacture all the standard sizes, such as Pompeian, Norman, and common and ornamental brick of different patterns. Their largest market is in the eastern states, and while they ship some to Pittsburgh and neighboring towns the bulk of their trade is in the more eastern cities. They have been in operation for six years (since 1891) and



Fig. 33. Showing the works and mines of a Clay Co., in Beaver Co. The first mine above the main building is in the Lower Kittanning clay, and the upper one at the top of the long incline is in the Freeport clay.

have a capacity of 18,000 to 20,000 bricks per day. Nearly all their brick are re-pressed, dried in a steam drying tunnel and burnt in down-draft kilns.

Most of their clay is obtained from the bed of Lower Kittanning clay that is used so extensively in the potteries and brick works in this vicinity and which outcrops in the bluff at the works. They use some clay from the Freeport bed, higher on the hill, 170 feet above the Kittanning clay. Small quantities of shale from the bluff at the works are used for coloring material when different shades are desired. It is the aim of the progressive and enterprising manager to keep the works up to date both in the grade and in the colors of the bricks manufactured. The accompanying illustration, fig. 33, shows the works of the Fallston Fire Clay Co. and the relative positions of the clay mines and the facilities for delivering the clay to the works by the incline track and dump.

The Brady's Run Fire Clay Co, whose works adjoin those of the Fallston Co., manufacture some building brick but their chief trade is in paving brick. The property is now controlled by the Park Fire Clay Co., but still retains the name of the former company.

A. Dewhirst & Bro., New Brighton, Pennsylvania, operate a brick yard for the manufacture of common red brick on Marion Hill, about a mile southeast of New Brighton. The terrace clay is used, a thickness of four or five feet being worked from the surface. They have worked over an area of several acres, as the company has been operating for 23 years. They claim to have furnished much of the red brick that has been used for building in New Brighton and Beaver Falls, where all their product has been used. The clay is ground in an old style pug mill and the bricks molded by hand and burnt in the common open-top, up-draft kiln. There are two kilns with a capacity of 200,000 each.

A red brick works somewhat similar to the above, said to be owned by T. Dewhirst, is located on another part of Marion Hill, but is not in operation at present.

Mr. A. F. Smith & Son, who own the two fire-brick works at New Brighton, make some building brick along with the fire brick. They operated a red brick works on the hill above the present brick yard from 1852 until five or six years ago. The bricks were made from the yellow clay of the same terrace deposit as that used at the Dewhirst yard above. The flower pot industry of New Brighton is said to have started at this yard.

Levi Fish & Sons are said to have operated a red brick yard for many years on the hill near the Oak Hill pottery, and about a quarter of a mile east of the pottery. It is on the same terrace as the Smith and Dewhirst yards. It has been idle for many years and no particulars can be given.

BUILDING BRICK IN THE ALLEGHENY VALLEY. *

Freeport.—There is an abandoned brick yard about half a mile north of Freeport, on the west bank of Buffalo creek. The clay was obtained from the alluvial deposit on the creek bank and only common red bricks were manufactured. It is said to have been idle for three or four years and is now (August, '97) advertised for sale.

Ford City.—The Manor Brick Co. has operated a brick yard at Ford City since 1888, but the present officers of the company have had control of the works for only one year. G. B. Daugherty & Son started a yard adjoining this one at the same time, each company having a contract to furnish five million bricks for the large buildings of the Pittsburgh Plate Glass Works at Ford City. The Daugherty Company stopped when their contract was fulfilled but the other company continued filling other small orders, and a few years later had another order from the glass works for 11,000,000 bricks. They are now shipping bricks to Butler and have shipped to various points in the Allegheny valley.

They now use a wire-cut stiff-mud machine, with a capacity of 15,000 per day. They formerly used a soft-mud machine, with a normal capacity of 20,000 per day, but often run to 25,000 or 30,000 per day. They formerly used the clay from the river terrace deposit on which the town is situated, but they now use clay and shale from the river bluff back of the town, from which the clay is transported on a short tramway to the works. A section of the bluff shows the following strata:

Section of river bluff at the clay mine at Ford City.

Limestone, 8 feet.

Shale and clay, 3 feet.

Coal, 2 inches.

Fire-clay, 10 feet.

Blue-gray shale, 20 feet.

Coal, 2 feet.

Fire-clay, 8 feet.

The upper fire-clay and the shale are used for making brick. The lower fire-clay is not used. The clay and shale are ground in a dry pan, screened and mixed in a pug mill ready for use. Red building brick only are manufactured.

The Kittanning Clay Manufacturing Co. began operations in 1896, and is now fairly under way. J. H. Painter is president and Hon. G. W. McNees, secretary and general manager. The works are located in the ravine about 300 yards north of east of the A. V. R. R.

*See the following chapter, Chapter VIII, for works along the lower Allegheny Valley in Allegheny county.

depot in Kittanning. They manufacture red and buff building brick, red paving brick, fire brick, pressed brick, Pompeian brick, drain tile and chimney tops and lime.

The varieties of brick and tile are obtained by different admixtures of shale and fire-clay from their quarry located at the works.

Section of the clay and shale bank at works of the Kittanning Clay Manufacturing Co.

1. Soft brown shale, 30 feet.
2. Coal (Kittanning), 3 feet.
3. Fire-clay, 10 to 12 feet.
4. Blue-gray shales weathering yellow-brown, 15 feet.
5. Iron ore, 1 foot.
6. Limestone, 10 feet.
7. Fissile shale, 20 feet.
8. Soft fire-clay (reported), 10 feet.

Only numbers 1, 3 and 4 in the section are used for making brick.

The coal is mined for use in the town, but it is not used at the works, as the burning is done with natural gas, which is true of all the works in this vicinity. The limestone is quarried and burnt into lime for local usage. The soft fire-clay, number 8, and the lower part of number 7 are concealed below the bottom of the valley. The thickness given is that reported from borings. The clay and shale are ground in a dry pan screened, mixed in a pug mill and molded in a wire-cut stiff-mud machine. The tile are made in a similar type machine which cuts two pieces at a time. In the tile machine the clay is forced through an annular die in a continuous clay tube, which is cut by the wires into the lengths desired just as the clay bar is cut on the brick machine. They use two rectangular up-draft kilns and four round down-draft kilns.

The accompanying view (Fig. 34) shows the favorable location of these works. The clay and shale quarry, only partly visible on the right, at an elevation slightly above the works permits the materials to be cheaply moved to the grinding pans. Gas is furnished at the works from the neighboring pipe lines. The works are but a few hundred yards from the Allegheny Valley railroad with which they are connected by a side track, and over which the products are shipped.

The work of the company this year has been largely experimental, to determine the character of the clays, and the products for which it is best adapted. The following analyses made at State College shows the chemical character of the materials used.

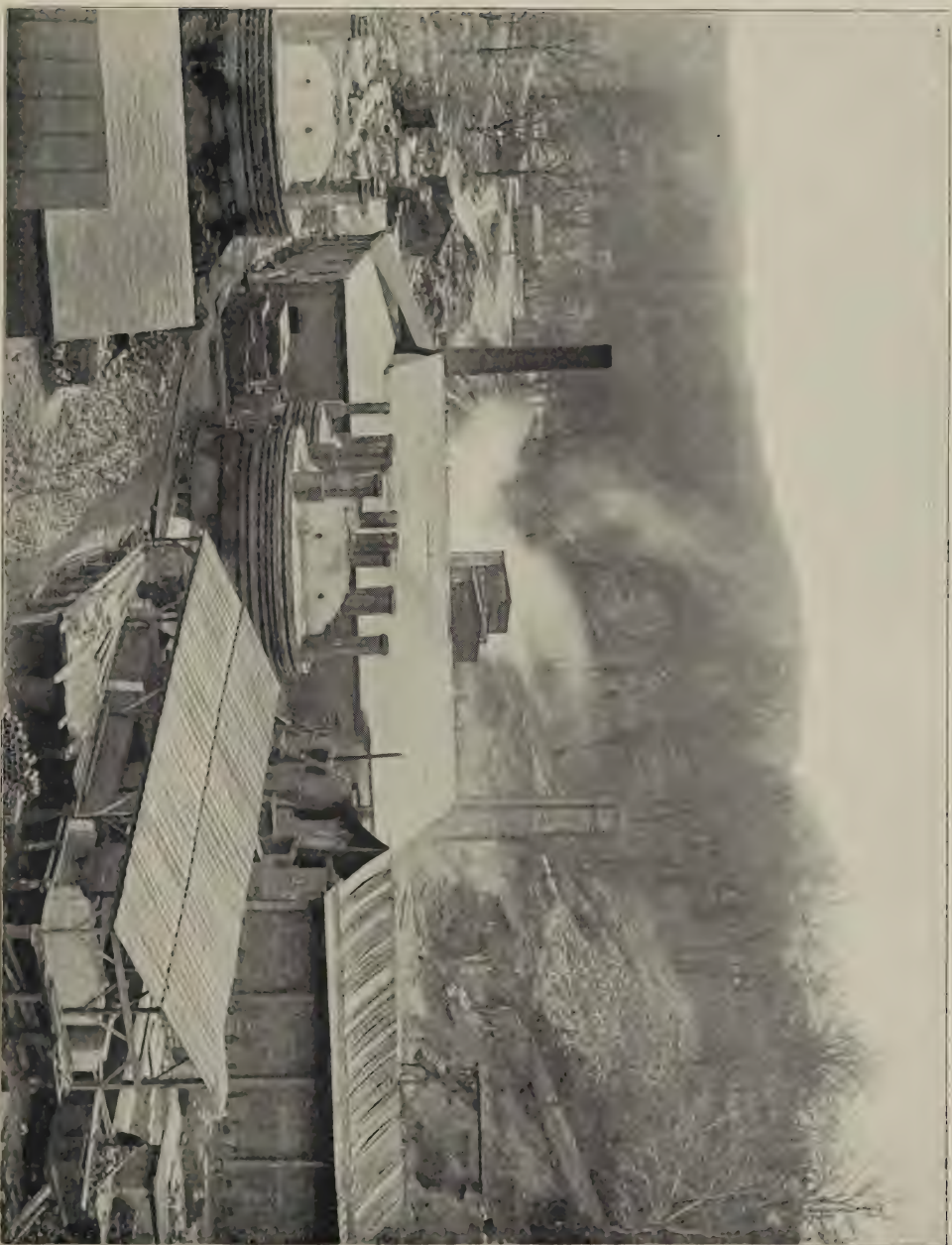


Fig 34. View of portion of the works and clay pits, Kittanning Pa. Clay pits on the right. Kittanning fire-clay and shales.

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Analyses of Kittanning clay and shales.

	1	4	7
Silica (SiO_2),	53.31	55.17	59.80
Alumina (Al_2O_3),	24.54	19.92	19.72
Iron oxide, (Fe_2O_3),	8.75	12.01	5.92
Loss on ignition (H_2O etc.),	8.55	6.81	8.59
Oxide of manganese (MnO_2),	0.38	....	....
	95.53	93.91	94.03

Analysis of fire-clay No. 3.

Silica (SiO_2),	60.40
Alumina (Al_2O_3),	26.23
Ferric oxide (Fe_2O_3),	1.34
Ferrous oxide (FeO),	0.23
Lime (CaO),	.14
Magnesia (MgO),	.54
Potash (K_2O),	2.66
Soda (Na_2O),	.28
Loss on ignition (H_2O etc.),	8.71
Total,	100.53

The numbers at the head of the analyses correspond to the numbers on the foregoing section of the bluff at the clay works. No. 3 is the fire clay underneath the Kittanning (Lower Kittanning) coal and at the same geological horizon as the clay mined so extensively at New Brighton and vicinity in Beaver county. Compare the analysis with that of some of the New Brighton clays (Table XI, Chapter IX). The analysis would indicate a clay suitable for stoneware and all varieties of building and paving brick, or a fire brick of low refractory power. Where red brick or tile is required with this strong body it could be obtained by mixing the shales of analyses 1, 3 and 4. These shales could be used alone for making red brick or drain tile and the fire-clay could be used alone or with a very slight admixture of shale for making vitrified brick.

The abundance of clay and shale material associated with the coal and an abundant supply of natural gas offers favorable advantages for the manufacture of various clay products at this locality.

The Kittanning Brick and Fire Clay Co. operates a brick works on the east side of the Allegheny Valley railroad about two miles above Kittanning. They have been in operation three years, have ten kilns, and are well equipped with machinery having a normal capacity of 24,000 bricks per day, but often exceeding that amount. The chief business of the company is in making a high class buff and gray

building brick. They claim to make one of the nicest building bricks on the market. They sell some paving brick and some fire brick, but these are mainly culls from the building brick, such as those lacking a uniform or a pleasing color which lowers their value for fine building brick, but are as good for paving or fire brick as those more uniform in color. As might be expected the fire brick are not highly refractory as all are partially fused (vitrified) in the burning. Besides the common sized brick they make the Pompeian, the Norman and ornamental brick of different kinds. They also make the dark brown and gray (manganese) spotted brick. The bricks are all carefully sorted as they come from the kiln to get uniformity of shade, and the odd shades laid aside for small orders or for paving brick. While they ship many bricks to Pittsburgh and vicinity, their largest markets are Boston, New York and other eastern cities. As they make only high grade brick, they command good prices, which justify shipping to more distant points than common bricks.

The bricks are made from fire-clay which is obtained from the mine on the hill above the works, and which is run by gravity down an incline railway into the works. The bed is said to be about 9 feet thick, the upper 6 feet being a light gray color and the lower 3 feet a dark color. The clay is ground in a dry pan, screened, mixed in a pug mill and run into the wire-cut machine. Some of the bricks are cut on the edge, thus giving the broad face smooth and some are re-pressed. All are burnt in the down-draft kilns with natural gas. The company is crowded with orders at present and apparently doing a prosperous business. The Pittsburgh office is at the foot of 10th street, and Mr. Sherwood C. Martin is president and manager.

BUILDING BRICK IN THE KISKIMINITAS AND CONEMAUGH VALLEYS.

The building brick industry in the Conemaugh valley is not extensive, there being only four works in operation, three idle, and one about to start.

Hyde Park.—The first brick works met in active operation in ascending the Kiskiminitas river is at the little village of Hyde Park, is operated by Kuhn and Schaeffer, and has been in operation about five years. They now have a capacity of 40,000 bricks per day, but rarely run to full capacity. They make red paving brick and building brick, which are all made on a wire-cut, stiff-mud machine, which cuts 13 bricks at a time. The material is ground in a dry pan, screened, mixed in a pug mill and fed into the brick machine.

The material used is bluish-brown shale quarried in the river bluff at the works. It contains a great many "iron balls," iron carbonate, and iron oxide, which are picked out by hand as the shale is quarried. There is a river deposit a few feet in thickness overlying the shale and consisting of sand, clay and boulders, all of which, except the boulders, are used with the shale in making brick.

The first efforts at brick making here were evidently attended with difficulty, as there are large masses of fused brick in the debris at the works caused by errors in the burning. The temperature would get too high for the quality of the clay used, and the result would be a melting and running together of the brick. Possibly not all of the iron balls were removed. They claim to have remedied this defect and are now making brick successfully under another foreman.

There is a small abandoned red-brick yard on the south side of the river at Leechburg, where red bricks were made from shale. There is a small abandoned yard on the south side of the river at Avondale station on the West Penn R. R., where the alluvium of the river valley was used. Apparently the yard has not been in operation for several years.

Blairsville.—The brick yard at Blairsville, owned by E. J. Graff, has been in operation for seven years. It has been leased and operated by the J. D. Neff Brick Co. since March, 1897. They manufacture red building brick from shale, and have made a few light colored brick, but not in commercial quantities. The capacity is given at 300,000 per year. The yard is located on the Indiana Branch Railroad, about a mile north of Blairsville. The principal markets are along the Pennsylvania Railroad between Altoona and Greensburg.

Blairsville Intersection.—On the south side of the Pennsylvania railroad about 300 yards west of the Blairsville intersection is a brick yard owned by J. K. Stark, of Greensburg, and operated by the Branch Brick Co., with Mr. Gwinn as superintendent. They make red brick only. The material used is shale, which is ground in a dry pan and molded in a wire-cut stiff-mud machine, which cuts eleven bricks at a time and has a capacity of 20,000 per day. The markets are points along the Pennsylvania Railroad west of the Intersection. The strata dip about ten degrees to the south of west and the part used for brick shows from three to four feet of yellow, sandy clay underlain by ten feet of crumbling brown shale, underlain by a lumpy blue to yellow clay, both the shale and underclay being impregnated with iron.

Reese, Hammond & Co., at Bolivar, are now adding a building and paving brick addition to their fire brick works (see page 83).

Louis Whein, of Johnstown, is said to be the operator of a small red brick yard at Sheridan, three miles below Johnstown, on the Pennsylvania Railroad. It is in operation on a small scale at irregular intervals.

Johnstown.—The Cambria Iron Co. has operated a brick yard in Johnstown for thirteen years or more. The yard is situated between the Pennsylvania Railroad and the Conemaugh river, about a mile below the iron furnaces of the company. They make a few pressed brick but most of the output is common red brick. The capacity is 30,000 per day and most of the product is used in Johnstown.

The works are well equipped with modern machinery and appliances. The clay is obtained up the river near the coke ovens and is brought to the works on the railway. The cars are run up on an elevated trestle under a large shed and the clay unloaded in two long parallel heaps, where it is left to dry. From the drier portions of this heap clay is shovelled by workmen on a traveling belt running between the heaps, by means of which it is carried to the dry pans, where it is ground and goes through the pug mill to the brick machine, an automatic wire-cut machine, which runs the bricks out on a belt, from which they are taken and assorted, the sound ones being put on a metal car, whence they are transferred to the drying oven where they are dried over a coke fire and then transferred on the same car to the burning kiln.



Fig. 35. Photo of a dry pan in operation.

BRICK YARDS BETWEEN THE CONEMAUGH AND THE YOUGHIOGHENY RIVERS.

The brick yards along the Pennsylvania Railroad between Wall and Pittsburgh, that is, all in Allegheny county, are described by Mr. Affelder in Chapter VIII. Between Wall and Blairsville Intersection there is a number of small brick yards but the only ones of more than local interest are those at Irwin and Rumbaugh station, both belonging to the J. M. Rumbaugh Brick Co., of Greensburg, which company does a large business, the principal market being along the Pennsylvania Railroad between Altoona, Pittsburgh and Uniontown.

The Irwin yard was operated by the Irwin Red Brick Co. for several years but has been controlled by the J. M. Rumbaugh Brick Co. since January, 1896. The daily capacity is 30,000 red bricks, all made by machinery, part on the stiff-mud wire-cut and part on the soft-mud machines. They make some re-pressed brick. The bricks are made from shale obtained from a bed forty feet or more in thickness. A bed of blue-gray sandstone runs through the shale about fifteen feet from the bottom of the opening. The shale overlying the sandstone is softer, more crumbling and yellower than that underneath.

The works at Rumbaugh station (Calumet P. O.) have a capacity of 70,000 per day and have been in operation about nine years, the first four years by Mr. Rumbaugh alone, since then by the J. M. Rumbaugh Brick Co. They make red building brick, some re-pressed and soft-mud brick and all are machine made.

The bricks are made of shale which is quarried near the works and run into the yard on a tramway. The shale is worked to a depth of fifteen to twenty-five feet, the lower part having a blue-gray color, the upper part oxidized to a yellow-brown and more crumbling than the fresh portions. It burns to a bright red.

The bricks made by this company in its three different yards include high grade, handsome red building brick and the common red building brick. The favorable location of the yards for shipping combined with the quality of bricks produced, gives them a large market along the Pennsylvania Railroad.

W. W. Parks has operated a brick yard in Greensburg for the past eight years that has a daily capacity of 7,000 bricks and produces both common and pressed brick. The material used is a mixture of shale and sandstone. The shale alone is said to burn a pale color and the sand is used to give the brick a bright color.

The Standard Brick Co., at Jeannette, has operated a brick yard at that place for the last five years. It was operated by another company three years before it came into the possession of the Standard Co. They use a Martin soft-mud machine with a nominal capacity of 15,000, but frequently reached 18,000 per day. The bricks were made from shale and the company has used all the raw material in its possession and is now (July, 1897) stopping work for lack of material. They made a few pressed brick but most of the output was common red brick. The output for 1896 was about 3,000,000 bricks.

At Latrobe there are two small brick yards that are in operation at irregular intervals. Both are idle in July, 1897. One is said to belong to Mr. Wm. Showalter, the other to Mr. Patrick Dalton. Both have two open square kilns and manufacture common red brick by hand from the alluvium of the creek bottom.

At Ligonier Mr. John Robb operates a small brick yard, making common red brick. The brick are made from alluvium dug from the

meadow on the south side of Loyalhanna creek. The clay is ground and tempered in an old style pug mill and the bricks molded by hand. The yard has been operated during the summer months for about twenty years.

About half a mile west of Ligonier is an abandoned brick yard that was operated by the Ligonier Fire Brick Co. during 1895 and 1896. The company started, it is said, with the intention of making fire brick, but the shale did not prove to be a fire-clay and they made some red brick, but it appears that even these were not a success and the works were abandoned.

There is a small brick yard at Mt. Pleasant said to belong to Mr. J. P. Loud and operated by Mr. Charles Hays. No particulars are at hand concerning it further than that it does not do a very extensive business.

IN THE YOUGHIOGHENY VALLEY.

Connellsville.—Soisson & Schlosser started a brick yard about one and a half miles south of Connellsville in November, 1896, where they make building and paving brick and some pressed bricks for fronts. They use a stiff-mud wire-cut machine, with a capacity of 8,000 per day. They have used clay from several beds near the works and are now (July, 1897) using surface clay obtained in the yard.

Mr. Jos. Stafford has operated a small brick yard about half a mile southeast of Connellsville. It is not in operation this year (1897). The material used as shown in the pit was three to four feet of surface clay and four feet or more of soft, dove-colored fissile shale.

Bird & Fancher started a brick yard along the Baltimore and Ohio Railroad a half mile below the Connellsville depot, in the summer of 1897, and burned three kilns of common red brick. The material used was a river deposit of clay and sand containing numerous boulders. The bricks were all made by hand from the material mixed in the old style pug mill, run by a horse.

Layton.—The Layton Fire Clay Co. at Layton station, make large quantities of buff building brick, besides fire brick and paving brick. (See Layton, under fire brick. Chapter V.)

West Newton.—Mr. John F. Caruthers has manufactured red brick at West Newton for eighteen years. The yard is on the west side of the railway track about half a mile below the West Newton station. The material used is the alluvium from the river bank, which is worked to a depth of eight or ten feet, in a few places fifteen feet or more in depth. The bricks are molded in a soft-mud machine which molds six bricks at once. The capacity is given as 10,000 per day but the works are only operated about two months in the year.

About two miles below West Newton on the east side of the railway track is the brick works formerly operated by Funk, Grantham and

Humphrey, but since May, 1897, by Mr. T. A. Humphrey. The bricks are made by machinery, having a capacity of 20,000 per day. The material used is a mixture of clay and shale.

A section of the quarry shows:

1. Surface clay, 3 to 5 feet.
2. Limestone, 4 to 5 feet.
3. Shale, rusty brown, black and gray, 6 to 8 feet.
4. Flagstone, 8 to 10 feet.

All of the material is used, numbers 1 and 3 used for brick, number 2 is burnt into lime and number 4 is used for flagstone.

There is a small brick yard using the alluvium of the river bottom about half a mile below Dawson, on the west side of the Youghiogheny river. It was formerly operated by Mr. Thomas Williams and is now said to be owned by Mr. P. G. Smith. It is only operated at irregular intervals.

UNIONTOWN, FAIRCHANCE AND SMITHFIELD.

Uniontown.—There are two brick yards at Uniontown, both making red brick. John N. Brownfield has operated a brick yard here for fifteen years and manufactures common red brick, all machine made, the works having a capacity of 10,000 per day. The bricks are burned with natural gas. The clay is dug from the surface and while he only works a thickness of about six feet it extends much deeper. He ships bricks to all parts of the coke regions.

The other Uniontown yard, which is operated by J. V. Williams & Co., has been in operation about 50 years: by J. V. Williams & Co. since March, 1897; by J. V. Williams alone for 28 years, and before that time by his father. They manufacture red building brick only and have a capacity of 25,000 per day. The clay used is a bluish sandy clay, weathering a reddish brown, and is dug from a bed about 14 feet thick. It is underlain by 14 inches of iron ore, underlain in turn by about 12 feet of blue clay. The clay is crushed and carried on a belt to the brick machine. The bricks are molded on a soft-mud machine which molds six bricks at a time. They are loaded on cars at the machine, which are first run into the drying tunnel and thence to the kiln to be burnt, where they are burnt with natural gas. The simple up-draft kilns are used.

Fairchance.—There are two brick yards in operation at Fairchance, one just started and the other 15 years old.

The Fairchance Brick and Tile Co. (Laughery & Densmore), are now (July, 1897), burning their first kiln. Their yard is between the Pennsylvania and the Baltimore and Ohio Railroad tracks, about 200 yards north of the railway station. They use an auger stiff-mud machine and a steam repress said to have a capacity of 15,000 per day.

They have had considerable delay by the breaking of the machinery. They make red brick only, using clay hauled in by wagon. The clay pit was not visited.

The Fairchance Lumber and Brick Co. (owned by Mr. Martin, of Pittsburgh; J. N. Erskine, foreman), operates a brick yard more than a mile northeast of Fairchance, at the base of Chestnut Ridge. They have a tramway from the works to the railroad. The yard has been in operation five years at its present location and ten years previously at another location in the vicinity. They have a capacity of 350,000 to 400,000 per month and make both building and paving brick. This is the first season they have made paving brick, the previous trade being wholly in building brick, largely dry-press building brick of fine quality that commands a good price. Their clay is mined from a bed of soft clay about nine feet in thickness, which is said to be underlain by seven feet of harder clay that is not used because it is harder, hence more difficult to work. Coal from the coking region west of the railway is used for fuel.

There is a small brick yard, apparently not now in operation, at Hutchinson station, and another along the railway between Fairchance and Uniontown. Mr. A. J. Hayden is now starting a small brick yard on the east side of the railway near Smithfield station. The material used is yellow surface clay, which is mixed in an old style horse-power pug mill and molded by hand, then placed in the sun to dry and finally burnt in an open kiln.

Other parties are said to have burned brick in the vicinity of Smithfield, but no other yards are in operation at present.

THE RED BRICK INDUSTRY IN THE MONONGAHELA VALLEY.

Nearly all of the brick yards in the Monongahela valley make only common red brick and their markets are largely confined to the valley between Brownsville and Pittsburgh. Those in Allegheny county are described by Mr. Affelder in Chapter VIII.

Monongahela City.—J. T. Conlin has been manufacturing common red building brick at Monongahela City for 25 years. For 12 years his yard was on the old pike near town, but for the past 13 years he has been working on the west bank of the Monongahela river about half a mile below the railway station. The material used is the alluvial deposit on the river bank. The capacity of the yard is 5,000 bricks per day. He ships some by rail and some by river, as far as Hazlewood and Duquesne, but most of the product is marketed at Monongahela City.

About 200 yards south of Mr. Conlin's brick yard is another that was first started by Mr. Ford and afterwards operated by Mr. Leidy, but since the death of Mr. Leidy about three years ago the yard has been idle.

Charleroi.—The Charleroi Brick Co. has been making red brick at Charleroi for five years. Their works are situated about half a mile north of the town on the west bluff of the Monongahela river, and have a capacity of 20,000 per day. The markets are along the Monongahela division of the Pennsylvania railway, and they have so far been crowded with orders. The bricks are all common machine-made red brick, no repress brick. The material used is a mixed red and yellow clay quarried on the river bluff near the works. A section of the present quarry face shows:

Surface clay, 3 to 5 feet.

Shelly sandstone, 4 to 10 feet.

Yellow clay, 4 to 5 feet.

Red clay, 15 to 20 feet.

The red clay used at this point outcrops in a number of places in the vicinity of Charleroi. There is a fine exposure of it in the little valley just south of the town.

Analysis of red clay and gray shale from south side of Charleroi.

	Red clay. Per cent.	Gray shale. Per cent.
Silica,	56.32	51.12
Alumina,	21.44	24.60
Iron oxide,	9.92	10.49
Loss on ignition,	6.73	6.59

Despite the marked difference in color and structure of these two materials, it will be noticed that they have a very similar composition. As is customary, the iron was determined as ferric, but not proven so. In No. 2 it is probably nearly all the ferrous iron and in the other the ferric. Both are rich enough in clay base to make a good strong brick, and both are too high in fluxes to make a good vitrified product. In comparing the two one would naturally infer that the red clay had a much higher percentage of iron than the gray, whereas the analyses show it to contain even less.

Fayette City.—About half a mile below Fayette city on the east side of the Monongahela river on the P. & L. E. R. R., the Dinsmore brothers have been manufacturing red brick since 1892. They also make a few fire brick. The brick are machine-made (soft mud), dried by steam in the drying tunnel, and burned in the open top up-draft kiln. Capacity 10,000 per day. The markets are mainly local, but they ship as far as Elizabeth.

The red brick are manufactured from shale obtained from the quarry on the hill above the works, where it is shoveled into a chute which conveys it into the works. The fire brick are made from the clay parting, the "horseback," in the Pittsburgh coal seam.

Section of the strata at Dinsmore Bros'. shale quarry.

	Feet.
Shale quarried for brick,	35
Shale, not quarried, partly concealed,	20
Pittsburgh coal seam and clay parting,	9
Shale,	10
Limestone and shale,	10
Shale,	8

It is only the upper part of the shale that is utilized, but the supply of shale is practically unlimited. The accompanying photo shows the structure of the shale in the quarry, Fig. 36.



Fig. 36. View of shale quarry.

California.—F. H. Martin has manufactured red brick in California for 25 years. The yard is situated on the west bank of the Monongahela river nearly half a mile south of the railway station. The bricks are made by wire-cut machine, which has a capacity of 40,000 per day, but the actual output is much below this. The bricks are burned in an intermittent 3-chambered kiln, which was erected this year (1897), previous to which they were burnt in rectangular up-draft kilns. The 3-chambered kiln while still in the trial state is said to have given good satisfaction in the three kilns already burnt in it. The markets are mostly local. He makes repressed bricks, but the greater part of the output consists of the common red bricks.

The material used is the alluvium from the river bank which is drawn up an incline into the works by the engine.

There is a small brick yard near New Geneva and another near Greensboro, where small quantities of red brick have been manufactured for local usage, but the yards have not been operated for a number of years.

Paving brick industry.—The paving brick industry in western Pennsylvania is not at all commensurate with the fire brick or building brick industry. The following companies make paving brick in limited quantities along with other classes of brick: Jos. Soisson Fire Brick Co., Connellsville; The Layton Fire Clay Co., Layton; The Kittanning Clay Mfg. Co., and the Kittanning Brick and Fire Clay Co., both at Kittanning; The Fallston Fire Clay Co., Fallston; The Burl Fire Brick Co., Black Lick; Kountz Bros. Harmarville; Park Fire Clay Co., Rochester; Hiram Swank's Sons, Johnstown; Dunbar Fire Brick Co.; Eureka Fire Brick Works, Mt. Braddock; Fairchance Lumber & Brick Co.; Kuhn and Schaeffer, Hyde Park; Blatchford, Meeds & Co., Barking; Reese, Hammond & Co., are about to begin the manufacture of paving brick at Bolivar as this goes to press. The Pittsburgh Clay Mfg. Co., at New Brighton did manufacture large numbers of paving brick a few years, but are making none now.

None of these companies manufacture paving brick alone, but only along with other kinds of brick. With most of them paving brick is purely a side issue and receives but little attention. With two of these, however, Kountz Bros. and Park Fire Clay Co., it is their principal business. The first of these is described in the following chapter; the second would give no information concerning their works.

A great many paving bricks are used in numerous towns of western Pennsylvania, and their use appears to be increasing rapidly, but many of them are shipped in from Ohio and West Virginia. Further mention of the paving brick industry of this portion of the State may be made in a future publication after the subject has been further investigated in other localities.*

*Time did not permit a general description of the paving brick industry, as was done with the fire brick and building brick.

CHAPTER VIII.

THE CLAY INDUSTRIES OF ALLEGHENY COUNTY.

By WILLIAM L. AFFELDER.

GENERAL STATEMENT.

The brick industry of Allegheny county has increased with wonderful rapidity during the past few years, until at the present time there are more than 50 brick yards in the county, almost half of which have begun operations during the present decade. A marked change has also occurred in the method of manufacture, for all the yards, with but few exceptions, have abandoned the hand mold and horse-power pug mill, and have adopted more modern and more economical steam-power machinery.

Of the brick machines in use, the Henry Martin soft-mud machine



Fig. 38. Emptying a kiln.

seems to be the general favorite, being used far more extensively than any other. Wire-cut auger machines, particularly the Freese and the Penfield are rapidly coming into prominence because of their large daily capacity and the ease with which they can be operated. The side-cut machine is used exclusively. An excellent example of the advantages of a wire-cut machine may be seen at Booth & Flinn's works, Pittsburgh, where a Penfield machine with an automatic cutting table is in use. It makes between 175 and 200 bricks a minute,

cutting 18 at a time. The advantage in such a machine is not only the rapidity with which it turns out the brick, but also in the fact that only one man is required to operate it. A wire-cut machine also has some disadvantages, the principal one being that it often makes a very rough brick when shale is used, and that it requires a very plastic clay. The soft-mud machine makes an evener and more shapely brick, but it requires more men to operate it in proportion to its output than does the wire-cut machine.

About 200 kilns are used by the brick manufacturers in the county, almost all of which are constructed on the common open-top, up-draft principle. Down-draft kilns are very rare, less than 15 of them being in use. Booth and Flinn have the only continuous kiln used for burning red brick in the county. With very few exceptions, open air



Fig. 39. Continuous kiln.

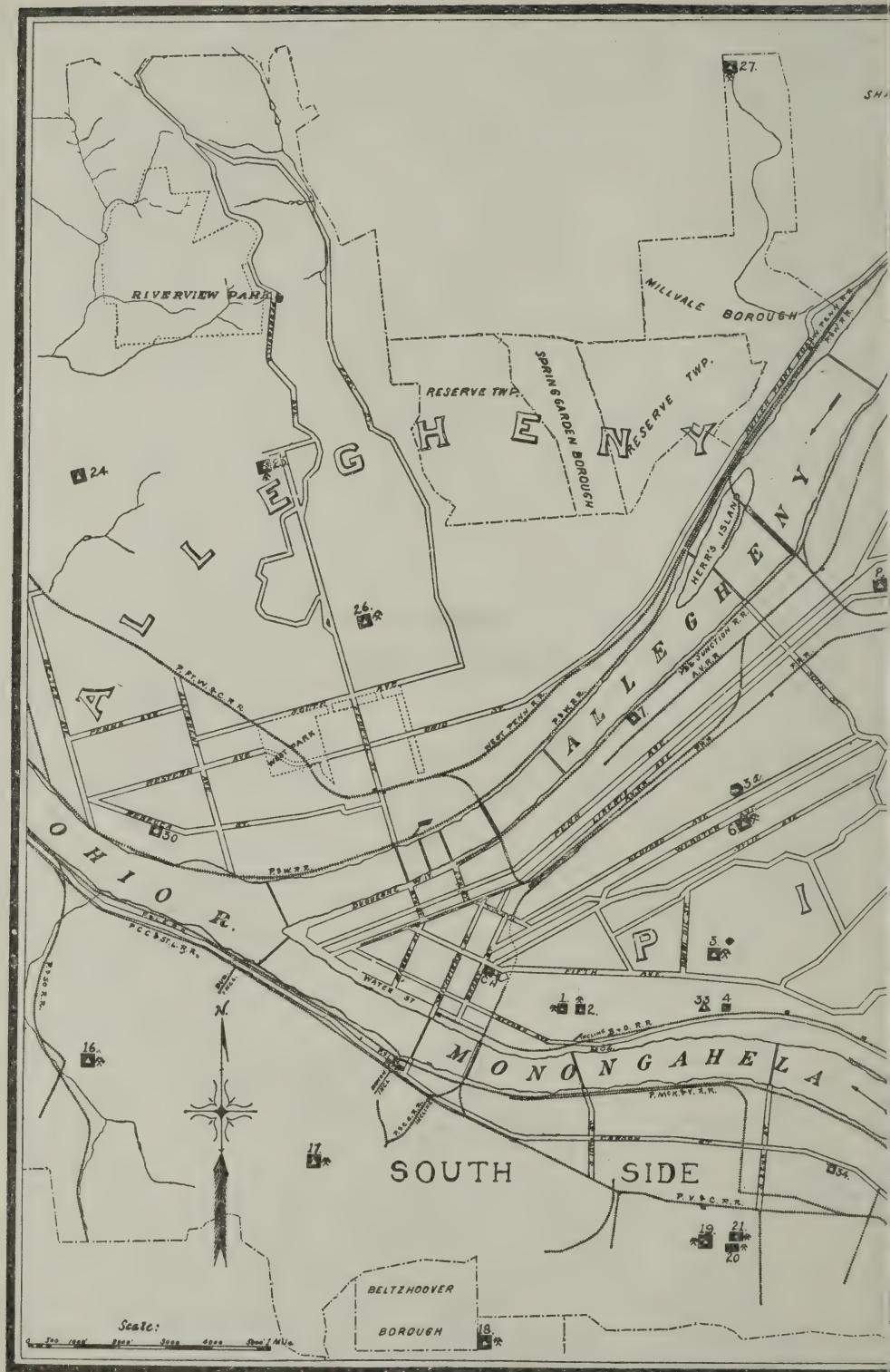
drying has been abandoned and more modern devices have been adopted. The dry floor is the common form of dryer in use, but tunnel dryers with either hot air or steam heat are also used extensively. Coal is used both for drying and burning, except in such regions where natural gas is cheaper. The manufacture of brick in this county gives employment to 1,500 men and boys, and the combined daily output of all the yards is slightly over 1,000,000 brick, valued at almost \$6,000. Large as the output is, most of the material is common red brick. A fair percentage of the output consists of "stock" brick, which is a grade of brick good enough for building fronts, but the manufacture of pressed and paving brick is rather limited.

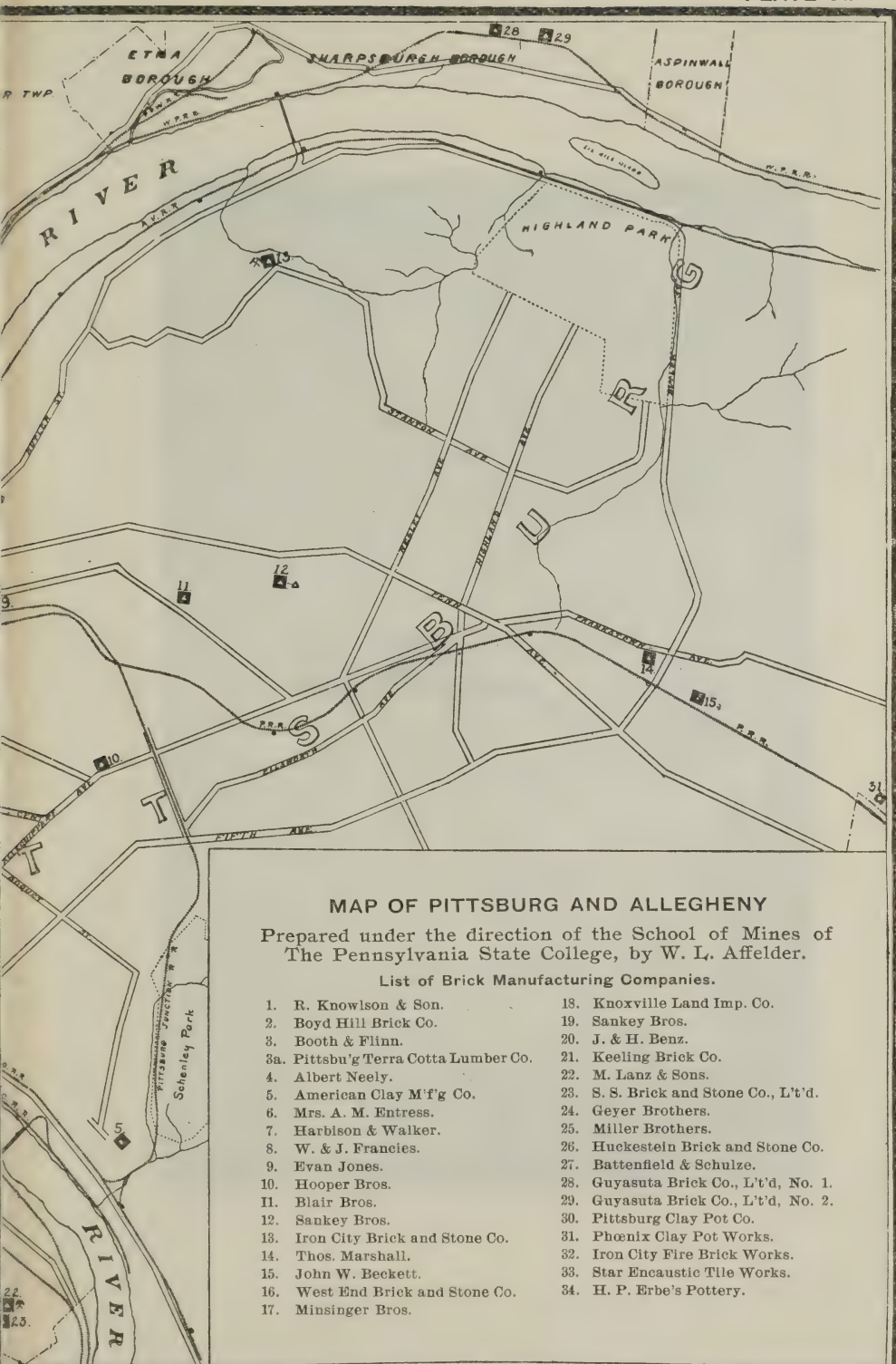
One of the strangest features of the brick manufacture in Allegheny county is the fact that so few paving brick are made. With the exception of the Kountz Brothers Co., of Harmarville, and Blatchford, Meeds & Co., of Barking, no company makes paving brick in any numbers. What makes this all the more strange is the fact that large numbers of paving brick are annually imported into this county from Ohio and West Virginia. There are several reasons for this. The brick manufacturers believe that "a bird in the hand is worth two in the bush." They are able to make good building brick, and the demand for such brick is sufficient to keep the yards busy during the greater part of the year. They are content with making such brick instead of experimenting with the manufacture of paving brick. It requires greater care in mixing and burning to make a good paving brick, and the manufacturers are not anxious to contend with the numerous difficulties and unsuccessful attempts which they would at first be compelled to encounter. The trouble is not that the material for making good paving brick is lacking, for several companies have succeeded in making some very good brick. Another reason for not making paving brick in this county is that the imported ones which are now in use have a good reputation. They have been repeatedly used with success and their qualities are known, whereas the brick made in this county would first have to establish a good name before there would be a demand for them.

The vital reason is the one advanced at a recent meeting of the Western Pennsylvania Brick Exchange; viz., that it does not pay to make them. This reason seems rather strange at first, until it is given some consideration. Bricks are very unpopular for street paving in Pittsburgh, because they have failed to withstand successfully the heavy traffic to which they were subjected. Since most of the brick yards of the county—the largest ones at least—are situated near Pittsburgh, it would be necessary for the manufacturers to ship most of their paving brick. After paying freight on them, the profit, if there would be any at all, would be less than that which they could make from manufacturing building brick and selling them at home. The West Virginia and Ohio companies do not have to pay much more freight on their brick when they ship them into this county than the local manufacturers, because of the greater quantities which they ship. Besides, these companies which have both reputation and experience in their favor, can and do undersell the inexperienced Allegheny county manufacturers who have hardly gotten beyond the experimental stage. In brief, the manufacturers of this county are content with letting well enough alone, and with very few exceptions, restrict their attention to making common brick, which they can do with profit.

The manufacture of fire brick is not an important industry in this

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MAP OF PITTSBURGH AND ALLEGHENY

Prepared under the direction of the School of Mines of
The Pennsylvania State College, by W. L. Affelder.

List of Brick Manufacturing Companies.

1. R. Knowlson & Son.
2. Boyd Hill Brick Co.
3. Booth & Flinn.
- 3a. Pittsburg Terra Cotta Lumber Co.
4. Albert Neely.
5. American Clay M'fg Co.
6. Mrs. A. M. Entress.
7. Harbison & Walker.
8. W. & J. Francies.
9. Evan Jones.
10. Hooper Bros.
11. Blair Bros.
12. Sankey Bros.
13. Iron City Brick and Stone Co.
14. Thos. Marshall.
15. John W. Beckett.
16. West End Brick and Stone Co.
17. Minsinger Bros.
18. Knoxville Land Imp. Co.
19. Sankey Bros.
20. J. & H. Benz.
21. Keeling Brick Co.
22. M. Lanz & Sons.
23. S. S. Brick and Stone Co., L't'd.
24. Geyer Brothers.
25. Miller Brothers.
26. Huckestein Brick and Stone Co.
27. Battenfield & Schulze.
28. Guyasuta Brick Co., L't'd, No. 1.
29. Guyasuta Brick Co., L't'd, No. 2.
30. Pittsburg Clay Pot Co.
31. Phoenix Clay Pot Works.
32. Iron City Fire Brick Works.
33. Star Encaustic Tile Works.
34. H. P. Erbe's Pottery.

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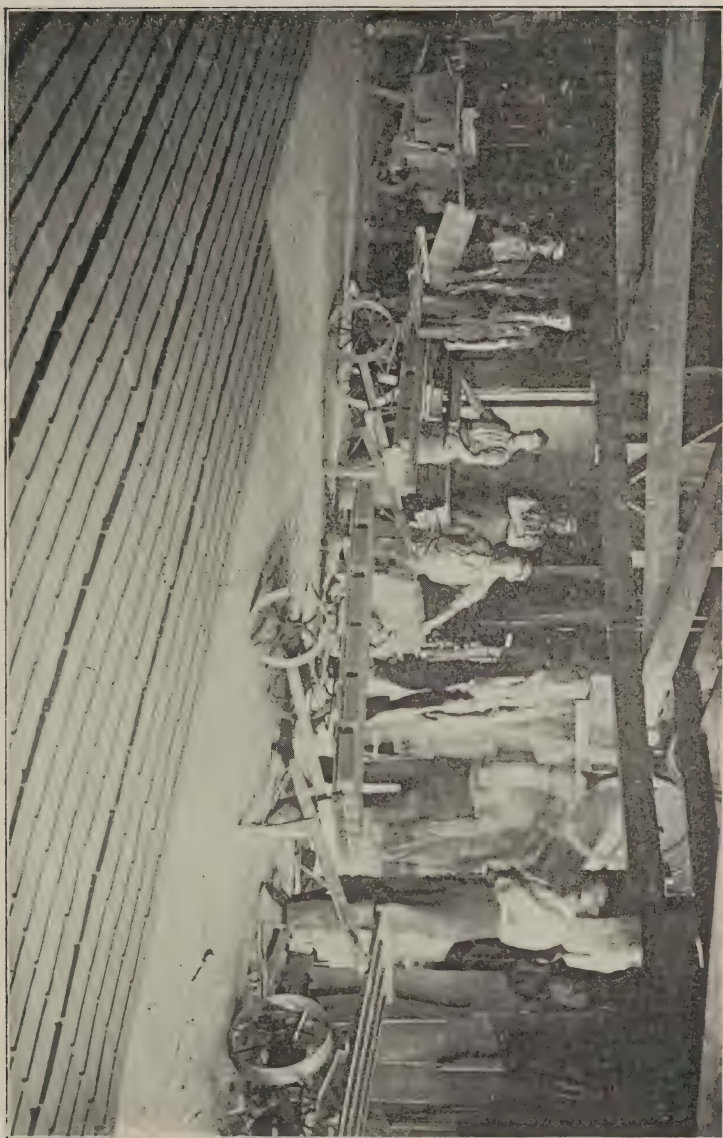


Fig. 40. A typical dry floor.

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county mainly from the fact that good fire-clays do not occur in a sufficient abundance to be worked. The only fire brick works of importance in the county are those of Harbison & Walker, in Pittsburgh. Their clay is imported from localities outside the county. (See Chapter V.) Several companies have experimented with varied success, with "horse back" obtained from coal mines, making it into brick of fair quality.

The clays and shales of this county are used very little for industries other than the manufacture of brick. There are several clay pot works in the vicinity of Pittsburgh, but they use imported clays. The Star Encaustic Tile Co., of Pittsburgh, uses clay obtained at the works and imported clays. The Pittsburgh Terra Cotta Lumber Co. makes large quantities of terra cotta lumber for ornamentation and for fire-proofing, using only the shale and clay which occur at the works. Only one pottery—that of H. P. Erbe (Pittsburgh)—is located in the county. It is a very small one at which little other than earthenware is made.

Shipping facilities in the county are excellent, but the markets of the manufacturers are almost entirely local. Besides many railroads, there are four navigable rivers: the Ohio, Monongahela, Allegheny and Youghiogheny.

CLAYS AND SHALES.

The Lower Barren Coal Measures constitute by far the greater part of the surface rocks of Allegheny county. In fact, all of the northern half of the county with the exception of small areas of Upper and Lower Productive Measures, and about one-half of the southern part are covered by the Lower Barren formations.

SECTION OF THE LOWER BARREN MEASURES IN ALLEGHENY COUNTY.*

	Feet.
1. Pittsburgh coal bed,	..
2. Fire-clay,	3
3. Shale,	10
4. Limestone,	6
5. Coal bed,	1
6. Shale,	25
7. Limestone,	3
8. Shale,	10
9. Coal bed,	1.5
10. Limestone,	5
11. Connellsville sandstone,	60
12. Shale,	35
13. Coal bed,	1
14. Limestone,	4

*Report KK, Second Geological Survey of Penna., p. 65.

	Feet.
15. Morgantown sandstone,	50
16. Clay,	9
17. Barton coal bed,	1
18. Shale,	36
19. Crinoidal limestone,	4
20. Shales and clays,	100
21. Coal bed,	2
22. Shale,	60
23. Black limestone and shale,	4
24. Shale and shaly sandstone,	35
25. Coal bed,	2
26. Shale,	30
27. Mahoning sandstone,	..
Total,	491.5

One glance at the above sections will show what an enormous amount of shale there must be in this county, for 349 feet, which constitutes about 71 per cent. of the total thickness of the series of 491.5 feet is shale, or shaly sandstone, and clay. At Pittsburgh, where 320 feet of strata of the Lower Barren Measures are exposed between the level of the Monongahela river and the outcrop of the Pittsburgh coal near the hilltop, almost all of the rock is shale. So enormous are the deposits of shale that the manufacture of brick can be carried on for centuries without materially diminishing the amount. Abundant as the shales are, they do not vary greatly in general characteristics. Almost all of them, with the exception of the very arenaceous ones, are well adapted to the manufacture of brick. All of them show evidence of iron to a greater or less degree. In some the prevalent state of the iron is the ferrous, while in others it is the ferric, but all of them are stained with ferric iron, especially after they have been subjected to the action of the atmosphere. By far the most common variety of the shale is the yellowish, slightly arenaceous one, which grades at the surface to a sandy clay and as the depth increases, to a more or less impure sandstone. Bluish shales are common in some localities. Some of them are so argillaceous and distinctly laminated as to look very much like slate, but the majority of them are shelly and readily disintegrate to small flakes. In color they grade from slate to bluish-gray. Recently M. Lanz & Sons, of Pittsburgh, have experimented with a bluish shale which occurs under the shale deposit from which they obtain their material for making red brick, and succeeded in making a buff brick of good color and quality for building purposes. Greenish shales con-

taining much ferrous iron occurs less frequently than the blue. They are always badly discolored because of the action of the atmosphere. Red shales are not very abundant. Where they do occur they are generally disintegrated on the outcrop to a red clay.

Clays also occur quite abundantly in this county. They may be divided into four distinct classes: (1) residual clays or those resulting from the disintegration in situ of shales; (2) fire-clays and other interstratified clays; (3) alluvial clays; and (4) terrace clays. The clays of the first group generally have the same general characteristics as the shales from which they have been formed as far as chemical composition and color are concerned. In some instances, the clay is redder than the shale owing to the fact that the iron has become oxidized. The extent of such clays depends upon the amount of disintegration and erosion to which the shales have been subjected.

Fire-clays are not abundant in this county and where they do occur they are too impure to be used for making fire brick. In some localities these clays are used to advantage in making building or paving brick. At Harmarville, an excellent reddish-buff repressed brick is made from a ten-foot vein of such clay. The presence of a small amount of iron prevents uniformity in color and the brick are only adapted to paving. At Briggston a very hard building brick is made from an impure fire-clay mixed with hard shale.

Alluvial clays are used for making building brick at about ten per cent. of the yards. The clays used at these yards are obtained from the river flats which border on the Ohio, Allegheny, Monongahela and Youghiogheny rivers. In several instances the clay banks are so near the level of the present river beds that they are occasionally flooded. The principal advantage of such clays over shales and clays formed in situ is that they can be made into brick more economically. They are very easily quarried and are sufficiently homogeneous to make brick of uniform color. The alluvial clays can be hauled direct to the pug mill, whereas shales must first be ground and screened, which operations require machinery and entail considerable expense.

Terrace clays are quite abundant in the vicinity of the rivers, especially in and near Pittsburgh. They generally lie unconformably upon the underlying rock, and as their name implies, form terraces more or less parallel to the present river beds, but through erosion they have lost, to a considerable extent, their original form. The clays obtained from these deposits, like those of river flats, are generally sandy and contain gravel and boulders of various sizes. Terrace clays are used at a number of the brick yards in the county.

THE BRICK WORKS OF ALLEGHENY COUNTY.

a. Pittsburgh.

1.* *R. Knowlson & Son.* Office and yard, Vickroy st. near Magee st. —The brick yard of Knowlson & Son is among the oldest of those in the vicinity of Pittsburgh, having been in operation for about 50 years. The company employs 25 men and boys, who turn out 15,000 common red brick per day. The brick are dried on a dry floor and are burnt in four up-draft kilns, natural gas being used both for burning and drying. The market is entirely local.

The material used by this company is obtained from the same stratum as that used by the Boyd Hill Brick Co. (No. 2), consisting of a deposit of shale underlain by about 12 feet of good sandstone which is quarried for building purposes. The upper part of the shale de-



Fig. 41. A portion of a brick works, Pittsburgh.

posit in Knowlson's quarry is distinctly blue in color. This, together with a dark red clay which occurs in a pocket in the shale, burns to a fairly good vitrified brick. Mr. Knowlson claims to have made a very good and durable paint of it.

2. *Boyd Hill Brick Co.* Office and Yard, Corner of Vickroy and Magee Sts.—This company has been operating for 12 years. The daily output of 20,000 consists of common red and a few sidewalk

*The consecutive numbering of the brick works agrees with the numbering on the accompanying map of Pittsburgh and Allegheny and in table in Chapter IX.



Fig. 42. Some up-draft kilns, Pittsburg.



Fig. 43. Shale and clay quarry, Pittsburg.
Showing the method of mining clay with the steam shovel.

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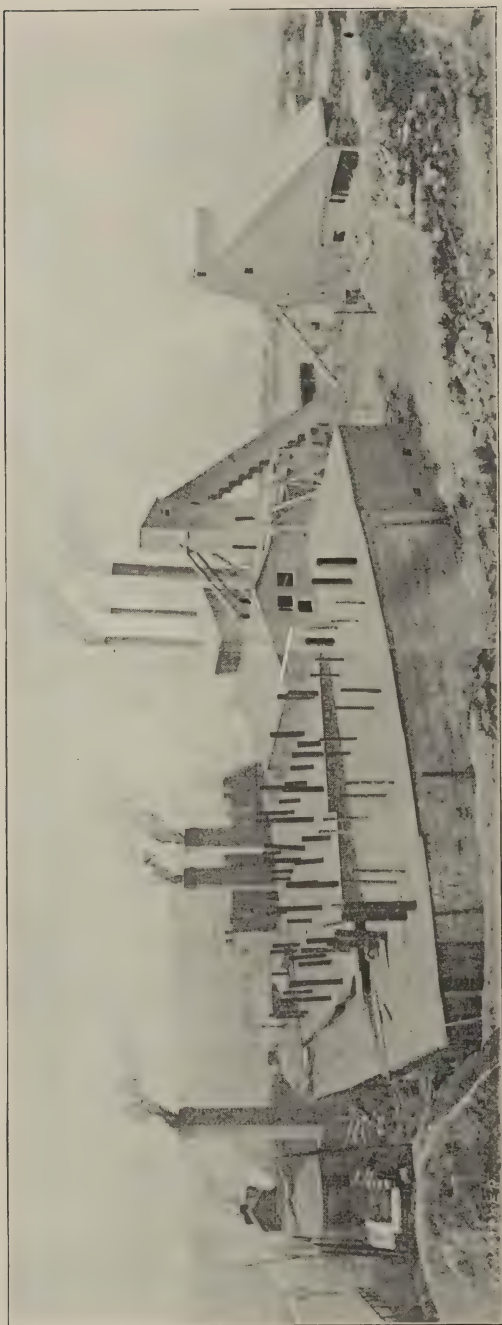


Fig. 45. Birds-eye view of a terra cotta works, Pittsburgh.

paving brick. They are dried in hot-air tunnel dryers and are burned in four up-draft kilns. The market is entirely local.

The clay and shale used by this company are obtained in an old sandstone quarry at the works. The stone, which is a good blue sandstone about 12 feet thick, has been exhausted except at the extreme western end of the quarry. Overlying this stone is a bed of yellowish, arenaceous shale about 25 feet thick, which becomes less arenaceous and more laminated towards the top. As the quarrying progressed from east to west, this shale was stripped off, was thrown behind, and has subsequently disintegrated to a five-foot bed of yellowish brown clay. The pit formed by quarrying the sandstone has also been partially filled with yellow clay hauled from excavations made at different places in the vicinity. This foreign clay, together



Fig. 44. Entrance to coal mine, Pittsburgh.

with the disintegrated shale and the shale above the sandstone, are mixed and made into brick. The quarry is still worked for stone, but the supply will be exhausted at an early date.

3. *Booth & Flinn*. Office, 1942 Forbes st.; Yard, Ruch's Hill, head of Lombard st.—Booth & Flinn have been making brick for 8 years and now operate the largest and best equipped yard in Allegheny county. One hundred and eighty men turn out 125,000 brick per day, five per cent. of them being stock brick, and the remainder common red. Two stiff-mud, wire-cut machines are used, one cutting 18 and the other 12 bricks per cut. The bricks are dried in steam tunnel dryers and burned in nine up-draft kilns having a combined capacity of 4,000,000 brick and a continuous kiln consisting of fourteen chambers each holding 18,000 brick. Booth & Flinn's market includes all sections of Pittsburgh and Allegheny.

The shale occurs apparently at about the same horizon as that on Boyd Hill.

Section of the shale and clay at Booth & Flinn's.

	Feet.
Yellowish, disintegrating shale and clay,	20
Red shale with interstratified yellow clay,	30
Blue sandstone,	20

The lower part of the red shale is decidedly arenaceous. The crevices in the sandstone are filled with veins of calcite. All of the material is utilized. The sandstone is used for building stone and the waste is ground in with the shale for brick material. The shale is mined with a steam shovel which loads it into the tram cars in which it is transferred to the grinding pans.

On the hill 100 feet above the brick works, the company has an



Fig. 46. Cutting tile.

opening into a six foot coal seam (Pittsburgh Coal Bed), from which the fuel is obtained for operating the works.

3a. *Pittsburgh Terra Cotta Lumber Co.* Office and Yard, 2400 Bedford ave.—This company manufactures the only terra cotta made in the county, and besides operating a large plant in Pittsburgh operates one at Port Murray, N. J. They turn out from 30,000 to 40,000 tons of material a year, which is shipped to many points in the eastern states and as far west as Houston, Texas.

The bottom of the bank from which the clay and shale used are obtained, consists of 15 feet of iron stained, bluish shale, which rapidly crumbles and disintegrates on exposure to the air. This shale is overlain by 15 feet of laminated yellowish shale which is so arenaceous that it might be called a shaly sandstone. Near the top of the

bank the shale has weathered to a six foot bed of sandy clay, in which there is an occasional outcrop of shale. All of the material with the exception of the hardest sandstone is ground in dry pans, screened,



Fig. 47. En route to the kilns.

and mixed with almost an equal quantity of saw dust in the pug mill. It is then molded to any desired shape in a Freese auger machine, is cut by means of a handsaw to pieces of desirable length, and is then

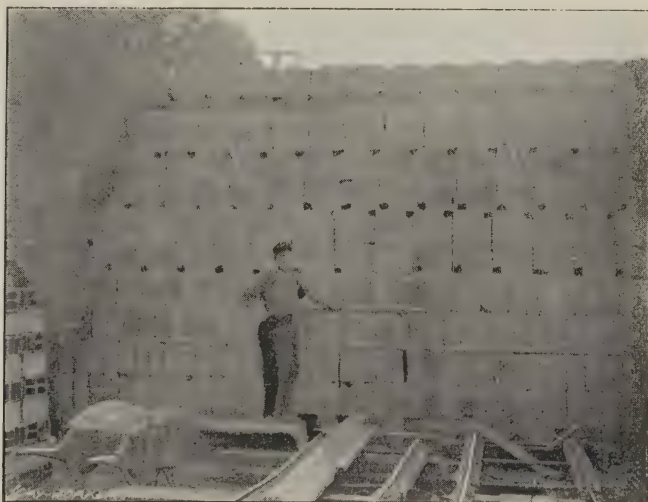


Fig. 48. Setting a kiln.

dried and burned in small round kilns. Mr. James O. Handy of the Pittsburgh Testing Laboratory analyzed a sample of the shale used and found it to contain:

Analysis of shale used by the Terra Cotta Lumber Company.

H ² O and organic matter,	7.517
SiO ² ,	57.537
FeO,	5.797
Al ² O ³ ,	20.127
CaCO ³ , MgCO ³ , Alkalies, } by difference,	9.022

4. *Albert Neely.* Office and Yard, corner of Tustin and Jumonville streets.—Mr. Neely makes common red brick by hand from clay hauled to his works from cellars and other excavations in the neighborhood. The works have now been in operation for almost 25 years. Five men are employed. The daily output is 5,400 common red brick, which are burned in three up-draft kilns. The market is entirely local.

5. *American Clay Manufacturing Co.* Office and Yard, Frazier street, near Griffith street.—The yard of this company has been operated for one year by the present company, previous to which time it was operated by Benney & Co., for three months. The daily output consists of 30,000 common red brick which are dried in steam tunnels and are burned with natural gas in three up-draft kilns which have a combined capacity of 550,000. The market extends throughout Pittsburgh and Allegheny. The company has a private siding from the Pittsburgh Junction Railroad.

The quarry of the American Clay Manufacturing Co., 200 feet long and from 15 to 40 feet in height, is in a hill situated west of Schenley Park. It consists of:

Sandy yellow clay, 3 feet.

Thinly bedded arenaceous shale, 8 feet.

Poor sandstone, 2 feet.

Clay, 30 feet.

The clay forming the bottom of the quarry is very hard and compact, and is of excellent quality. It is decidedly irregular in color owing to the action of the atmosphere upon the iron which it contains, but the prevailing color is reddish brown. The clay is exceptionally free from sand.

6. *Mrs. Annie M. Entress.* Office and Yard, Webster and Lawson streets.—Mrs. Entress' brick yard has been in operation since 1882. The daily output is 20,000 common red, stock, and sidewalk paving brick, which are dried on a dry floor and are burned by means of natural gas in three large up-draft kilns. The market is in Pittsburgh and Allegheny.

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Fig. 49. Views of yard, East End, Pittsburgh.

The clay and shale quarry consists of an opening 100 yards long and 30 feet high. At the bottom is a dark blue shale five feet thick, very arenaceous and containing mica flakes in considerable abundance, especially at the base where the shale grades into a dark gray sandstone. Above the blue shale is a yellowish shale which is only slightly arenaceous, except within ten feet of the top where there is a thin bed of sandstone, which again grades into a yellowish shale as the top of the quarry is neared, but the shale has almost entirely disintegrated to a yellow clay. Very little of the stone is suitable for building purposes.

7. *Harbison & Walker*. Office and Works, corner of Twenty-second street and A. V. R. R.—See Chapter V.

8. *W. & J. Francies*. Office and Yard, Corner of Liberty Avenue and Thirty-fourth street.—The Francies Brothers have been making brick since 1894, previous to which the yard was managed by other companies for 15 years. The daily output is about 20,000 common red, stock, select, and sidewalk paving brick per day. The bricks are dried on a dry floor with the use of coal slack for fuel, and are burned with natural gas in four up-draft kilns, the total capacity of which is a little over one million. The market is entirely local.

The shale and clay quarry worked by this company is about 75 yards long and 25 feet high. The top of the quarry consists of old river terrace deposits. Though this deposit is several hundred feet above the present bed of the rivers, the terrace is very marked and can easily be traced for some distance along both sides of Liberty avenue. There is a thickness of six feet of sandy clay and cobble stones, varying in size from small pebbles to boulders weighing two or three hundred pounds. The clay in this terrace deposit is quite sandy but makes good brick. No use is made of the cobbles. Underlying the terrace deposit is one foot of dark red clay which is quite persistent in this neighborhood and can be easily traced over a considerable area. The red clay is underlain by a bed of shale more or less disintegrated near the top to a variegated clay, but the lower part of the deposit is blue, iron-stained shale distinctly laminated.

9. *Evan Jones*. Office, Carnegie Building; Yard, Liberty Avenue and Thirty-sixth street.—Mr. Jones operates a brick yard across Liberty avenue from Francies' yard, and uses clay and shale which are exactly similar in all respects to the material used at Francies' yard. Four up-draft kilns and a dry floor are in use.

10. *Hooper Brothers*. Office and yard, Bellefield and Centre avenues.—Hooper Brothers have been making brick for seven years and are now making 15,000 common red, stock, select, and sidewalk paving brick per day. The brick are dried on a dry floor, heated by means of coal, and are burned in three kilns of 200,000 capacity each, by means of natural gas. The brick are all sold in Pittsburgh.

This company owns fifteen acres of a gently rising hill, directly back of the works on which is located their present quarry, the opening being about 200 feet long and 18 feet high. The upper 8 feet consist of very sandy yellow clay containing a considerable amount of very arenaceous shale, especially near the bottom. This shale does not occur regularly, but projects at different parts of the clay bed. Beneath this clay and shale bed is a five-foot bed of iron stained, exceedingly arenaceous shale, grading into a shaly sandstone which is in horizontal layers varying from a few inches to one foot in thickness. It is underlain by five feet of clay, yellow and slightly shaly at the top but devoid of shale below the middle. All of the material exposed with the exception of the hardest and most arenaceous shale, is used in making brick, which are burnt quite hard and well adapted to sidewalk paving.

11. *Blair Brothers.* Office and yard, Edmond street near Liberty avenue.—Blair Brothers have been operating their brick yard for twelve years but machines have not yet been introduced, the grinding being still done by horse power and the molding by hand. The daily output is 16,000 common red and stock brick. Natural gas is used both in the dry floor and in the five kilns. The market is local.

The material used by this company consists entirely of clay, obtained from a six-foot bed of yellowish terrace clay, which is rather sandy and shows no traces either of lamination or of gravel. The company has on hand a considerable amount of yellow clay which has been hauled to the works from neighboring streets when they were graded.

12. *Sankey Brothers.* Office, 2101 Carson street, S. S., yard, Atlantic near Penn ave.—These works have been operated by Sankey Brothers for the last two and a half years, previous to which time they were managed by Mr. A. E. Wentzell for two years and by Mr. Miller for 12 years. The daily output consists of 15,000 common red and stock brick, the two kinds being made in almost equal numbers. The bricks are dried in a tunnel dryer, and burned by means of natural gas in four up-draft kilns of 275,000 capacity each. The market is principally the East End.

The company uses clay obtained from a clay pit at the works and from another situated on the opposite side of Atlantic avenue. The clay of both pits is the same, consisting of 8 feet of slightly sandy clay upon which rests about one foot of gravel. The formation is undoubtedly the remains of an old river terrace. The gravel formation is very marked in the pit at the works, but is absent in most parts of the other pit. The prevailing color of the clay is yellow, but large irregular patches of it are gray. It is easily quarried and requires very little grinding.

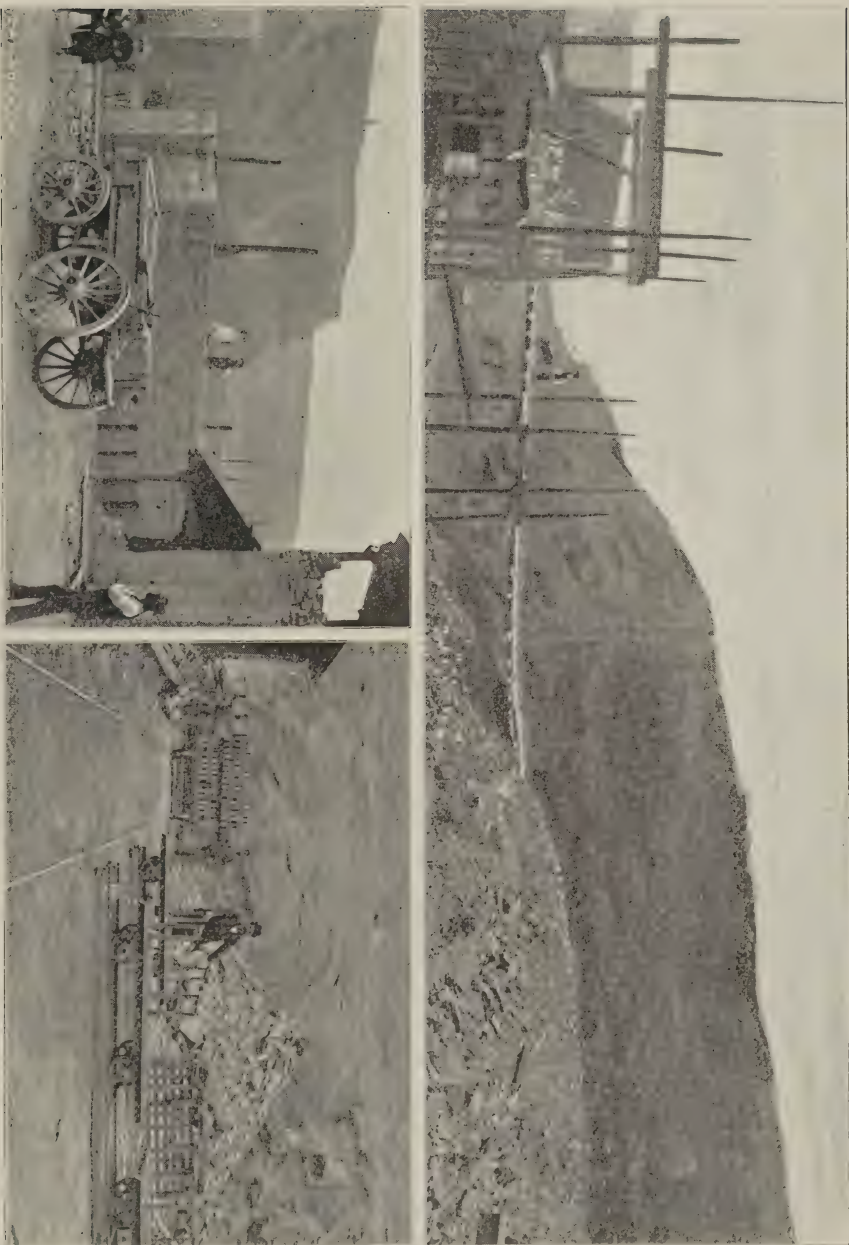


FIG. 50. Brick and stone quarry and works, Allegheny County.

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13. *Iron City Brick and Stone Co.* Office and yard, Stanton ave. and McCandless st.—The Iron City Brick and Stone Company has been in operation for 6 years, manufacturing common red brick, which are dried in a steam tunnel and burned in four up-draft kilns, each holding 300,000 brick. Natural gas is used for fuel and for burning the brick. The daily output is about 30,000 and the market is local.

The company owns 13 acres of land at the works. The present quarry face is about 100 yards long and 45 feet high. The upper 12 feet consist of yellow clay and shale, interlaminated with greyish clay. The upper 3 feet consist of sandy clay free from shale. Beneath this the shale grades into a soft sandstone which again changes rapidly to shale. Below this top formation of 12 feet is a 12-foot bed of hard, un laminated clay, which is of excellent quality and entirely free from sand. The first foot of this clay is bluish, underlain by a foot of yellow clay, followed again by blue, becoming more and more red toward the bottom, with a foot of blue clay at the base. Yellow clay occurs in irregular patches in the red clay. This clay rests upon 20 feet of thick-bedded sandstone of good quality. All the material above the stone is made into brick, and the sandstone is quarried and used for building purposes.

14. *Thos. Marshall.* Office, 5020 Cypress st.; yard, Kelly st. near Torrence st.—This yard has been operated by Mr. Marshall for one year, and by Mr. A. E. Wentzell for two years. The daily output is 6,700 hand-made red brick, which are dried on a dry floor and are burned in three up-draft kilns of 185,000 capacity each. Coal is used for all fuel. The brick are sold in the immediate vicinity of the works.

Behind the works is a ten-foot deposit of clay covering a limited area. It is of terrace origin, cobbles of various sizes being very numerous. The upper two feet of clay are very sandy, but the remainder is entirely free from sand. The clay consists of alternate layers of yellow and gray. It is easily ground in an old-fashioned, horse-power, pug mill.

15. *John W. Beckett.* Office and yard, corner of Hamilton and Dallas aves.—These works have been operated by Mr. Beckett for 20 years and now have a daily output of 15,000 brick, three-fourths of which are common red and the remainder stock brick. They are dried on a dry floor, and burned in four up-draft kilns, each holding 300,000 brick. Natural gas is used both for drying and burning. The brick are disposed of in the vicinity of the works.

The clay bank from which the material for making brick is obtained is situated across Hamilton avenue from the works. It is in the same terrace formation as Mr. Marshall's clay bank. The top of the formation is 15 feet above the street, and it is only being worked to the street level. The clay is of excellent quality, being hard yet

easily worked and being almost free from sand and gravel. The upper half of the clay is yellowish, but the lower part is brownish. Within two feet of the bottom there are several layers of almost white sand, each about three inches thick.

b. South Side.

16. *West End Brick and Stone Co.* Office, 121 Wabash ave.; yard, 35th Ward.—The works of this company have been in operation three years, and at present the daily output is 16,000 common red brick, which are dried on a dry floor and burned in three up-draft kilns whose combined capacity is 650,000. Coal waste is used for all fuel. The brick are sold principally in the West End district of Pittsburgh.

The works are situated on Saw Mill run at the bottom of a hill of



Fig. 51. Setting a kiln.

considerable height. The company obtains its material for making brick directly behind the works. The lowest visible formation is twelve feet of unlaminated yellow clay, which on account of its hardness breaks off in large irregular masses. Above this are three feet of red clay more distinctly laminated than that below it. Upon this clay rest 15 feet of thin-bedded sandstone which grades at the top into an arenaceous shale. A little further up the hill, this shale reaches a depth of more than 20 feet. The next formation is ten feet of good, red clay, which is in the form of clay at the surface, but is presumably shale further in the hill. Overlying the clay is a bed of 35 feet of excellent, thick-bedded, blue sandstone, which is quite calcareous; so much so in fact that it makes good material for macadamizing.

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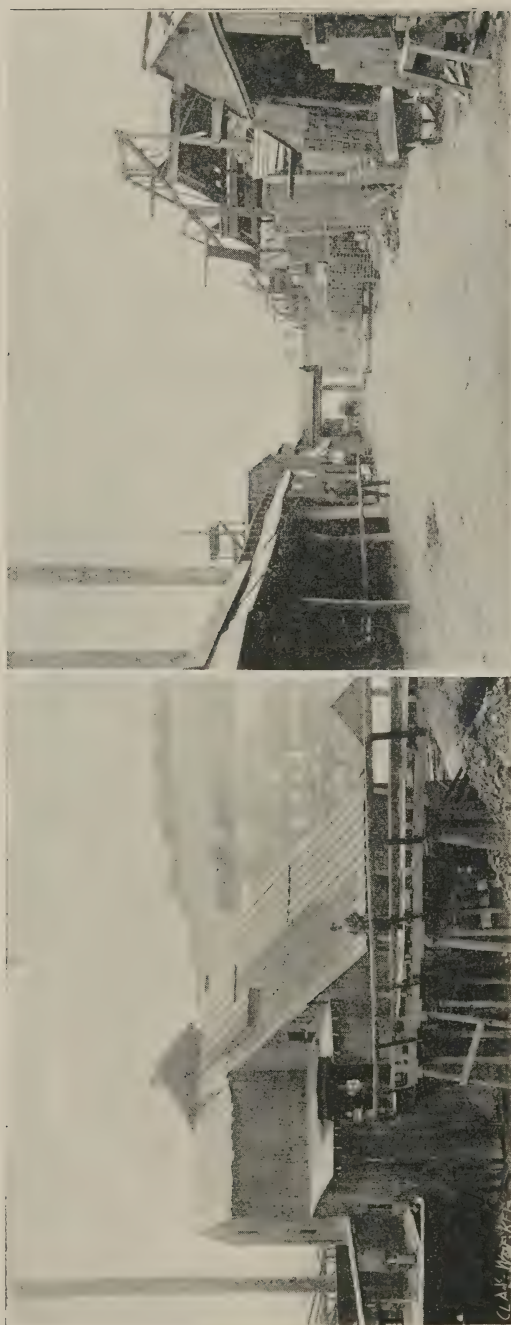


Fig. 52. A portion of a South Side works, Allegheny County.

The stone is quarried extensively by the company. Shale and clay overlies this sandstone, the thickness increasing with the distance up the hill.

The portion of the hill exposed consists of:

	Feet.
Shale and clay,	..
Sandstone	35
Red clay,	10
Shale,	20
Thinly bedded sandstone,	15
Red clay,	3
Hard clay,	12

The shales and clays above and below the sandstone are used in the manufacture of brick. At present, the bulk of the material used is stripped from above the stone, in order to allow the quarrying to progress. The shale and clay in this vicinity are inexhaustible as they constitute the bulk of the hill. There are several other points farther up the run where the same bed of sandstone is quarried by other parties.

17. Minsinger Brothers. Office and yard, Prospect st., Mt. Washington.—Minsinger Brothers have been manufacturing brick for 12 years, turning out 10,000 brick per day. The brick are dried on a dry floor and burned in three up-draft kilns of 200,000 capacity each. Natural gas is used for all fuel. The brick are sold in the Mt. Washington district of Pittsburgh.

Minsinger's quarry is the only one in or very near Pittsburgh situated above the Pittsburgh coal bed. The quarry face shows a bed of impure limestone overlain by four feet of very sandy clay, grading at the top to six feet of thinly-bedded sandstone. This sandstone is overlain by four feet of laminated, arenaceous shale, which, together with the sandy clay overlying the limestone, is made into brick. The remainder of the quarry consists of a 20-foot bed of gray sandstone overlain by 5 feet of clay, which is rendered worthless by the large percentage of lime present. The stone is being quarried extensively.

18. Knoxville Land Improvement Co. Office, 86 Knox avenue. Knoxville; yard, Knoxville.—The works of this company, which have now been operated for 16 years, give employment to 17 men and boys, who manufacture 7,500 common red and 2,500 stock brick per day. Natural gas is used for fuel in the four kilns. The combined capacity of the kilns is 900,000 brick. The brick are sold in and about Knoxville.

This company obtains its clay and shale from a quarry in a gentle slope, situated directly behind the works. Beneath about 20 feet of very poor sandstone, upon which rests three feet of sandy clay, are ten feet of very arenaceous shale. At the western end of the open-

ing the sandstone and shale thin out and disappear, and in their stead is a five-foot bed of yellowish and grayish clay, underlain by 15 feet of greasy shale, solid and somewhat arenaceous at the bottom, but becoming more clayey and less sandy towards the top. The sandstone increases in thickness and improves in quality farther in the hill.

19. *Sankey Brothers.* Office, 2101 Carson street, S. S.; works, South Eighteenth street.—These works are the oldest ones on the South Side, having been in operation for more than 30 years. The present company has had charge of the works for 16 years. The daily output is about 13,000 common red and 7,000 dry pressed brick, which are dried in steam tunnel dryers and burned by means of natural gas in six up-draft kilns, each having a capacity of 230,000. Some special shapes are made, the number depending on the demand. Most of the brick are sold in Pittsburgh, but some of them are shipped via the Pittsburgh, Virginia and Charleston Railroad and the Pittsburgh and Lake Erie Railroad.

The material used by this company is obtained from an extensive opening in the hill at the works. The upper five feet are yellow clay, and the remainder of the bank consists almost entirely of soft, clayey shale containing a great many segregations of impure limestone which are crushed and used on the roads in the neighborhood. The shale is about 30 feet thick and is underlain by three feet of alternating gray and yellow clay, which is underlain by greenish shale, containing a number of thin layers of red shale. All the shale is badly disintegrated, but traces of horizontal lamination are still very marked. All of the material exposed, with the exception of the limestone, is used in making brick. Beneath the shale deposit is very good sandstone which is being quarried.

20. *J. & H. Benz.* Office and yard, South Twenty-first street and Quarry Road.—The daily output of this company is 15,000 common red brick. They are dried in a Sach Radiated Heat Dryer, and burned with coal in four up-draft kilns of 250,000 capacity each. The works have been in operation for 15 years. The market is principally in the South Side, but some bricks are shipped via the Pittsburgh, Virginia and Charleston Railroad and Pittsburgh and Lake Erie Railroad.

The material used by this company is similar to that used by Sankey Brothers, being at the same geological horizon. Owing to the fact that the quarry is farther down the hill than Sankey's, the clay and shale above the sandstone are not so thick.

21. *Keeling Brick Co.* Office, 2014 Josephine street, South Side; yard, Quarry Road, S. S.—This company has been manufacturing brick for 10 years and turns out 15,000 common red brick per day. Five kilns, each having a capacity of 280,000 brick, are used. The brick supply a local market and are shipped via the Pittsburgh and

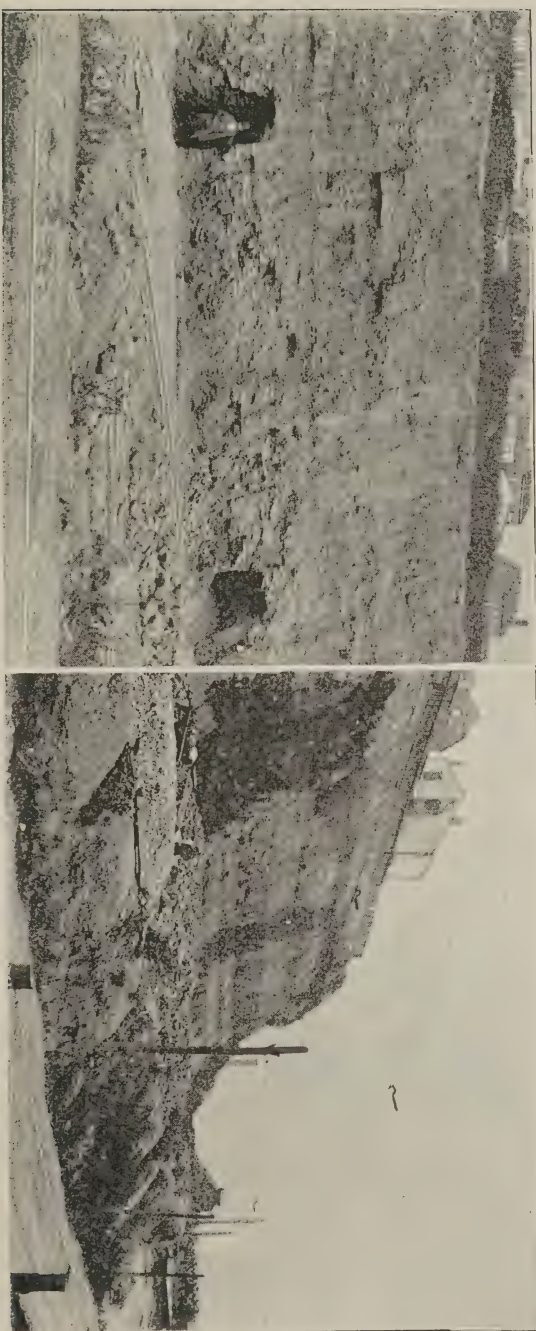


Fig. 53. A South Side quarry, Allegheny County.

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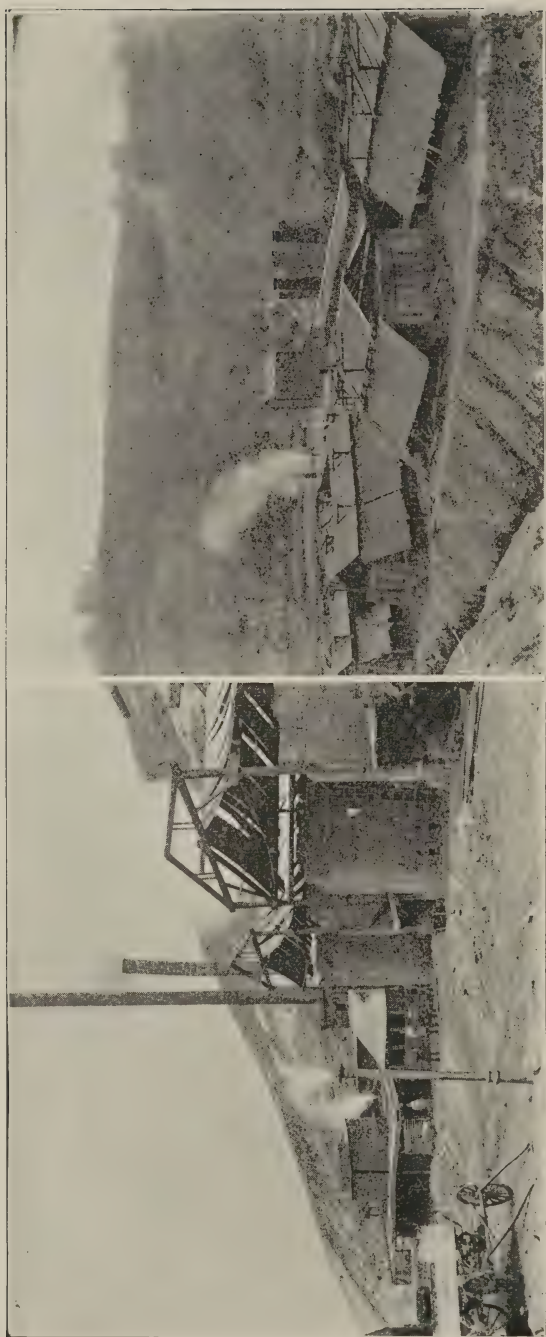


Fig. 64. Views of brick yard.

Lake Erie Railroad and the Pittsburgh, Virginia and Charleston Railroad.

The quarry of this company is situated on the hillside directly below that of Sankey Brothers. It is beneath the sandstone which forms the bottom of Sankey's and Benz' quarries. The brick are made from a 25 foot bed of shale which grades both at the top and bottom into sandstone, which is quarried and used as a building stone.

22. *M. Lanz & Sons.* Office, S. Twenty-ninth and Carson streets; yard, head of S. Thirty-fourth street.—This company manufactures about 20,000 brick per day, 20 per cent. being stock, 20 per cent. dry pressed, and the remainder common red. A few buff building brick have also been made from a bluish clay which occurs at the bottom of the quarry. The bricks are dried by steam and burned in five up-draft kilns, each having a capacity of 275,000, and are fired by natural gas. Although the company's market is almost entirely local, a few brick are shipped to points within ten miles of Pittsburgh via the Pittsburgh, Virginia and Charleston Railroad which passes directly below the works.

At the top of the bank from which the shale and clay are obtained, is a ten-foot deposit of good sandstone which is being quarried by the company. Beneath this sandstone are ten feet of sandy clay containing fragments of impure sandstone. This clay grades into a compact, laminated shale thirty feet thick, which has a greenish gray color near the top, but it becomes decidedly blue as the bottom is approached. Under the shale, which forms the present bottom of the quarry, is a blue, calcareous clay which crumbles to small nodules on exposure to the atmosphere. The company has been experimenting with this material and has found that it can be made into very good buff brick.

23. *South Side Brick and Stone Co. Limited.* Office and yard, head of S. Thirty-third street.—This company has been engaged in the manufacture of common red and stock brick for seven years. The daily output of 17,000 is burned in five up-draft kilns, each having a capacity of 250,000. The steam tunnel system of drying is used. The market is almost entirely local, but some little shipping is done via the Pittsburgh, Virginia and Charleston Railroad.

The quarry of this company is on the hill lying south of the Monongahela river directly above M. Lanz & Sons' quarry. The top sandstone of Lanz' opening forms the bottom of the S.S. Company's quarry. This sandstone, here about ten feet thick, is of excellent quality and is quarried extensively. Upon it rests a six-foot bed of distinctly laminated red shale which is rather arenaceous where it is in contact with the stone. The material making up the remainder of the exposure is 25 feet of shale, upon which rest five feet of sandy clay. The shale is yellowish in color, but is interlaminated with red. About ten feet below the top of the quarry is a seam of coal a few inches thick.

c. Allegheny.

24. *Geyer Brothers.* Office and yard, Woodland avenue near New Brighton Road.—This company is one of the few in the vicinity which has not yet adopted steam machinery. Hand molds and the horse-power pug are still used. The works have been in operation for ten years and give employment to ten men and six boys. The daily output of 7,000 brick is burned in three medium-sized, up-draft kilns. Both the dry floor and the kilns are fired with coal.

The clay bank of this company consists of a ten-foot bed of terrace clay deposited years ago by the Allegheny or the Ohio river. The clay is decidedly sandy, especially near the top, and is very easily worked. The upper two feet are light in color, but the remainder of the clay is brownish, the line between the two being decidedly marked.

25. *Miller Brothers.* Office and yard, Charles street.—Miller Bros. have been manufacturing common red brick for the past six years. The daily output is 25,000 brick, which are dried in steam tunnels and burned by means of coal in four up-draft kilns of 200,000 capacity each. The brick are all disposed of in Allegheny.

In the hill which is situated directly behind the works, is a large quarry of excellent sandstone about 18 feet thick. The fissures in the stone are filled with calcite which has been leached out of the overlying strata. Above the stone are two feet of sandy yellow shale, grading at the bottom into sandstone, and at the top into clay. The clay overlying the shale is 20 feet thick, consisting of very good reddish clay, bluish in spots and exceptionally free from sand. It is far more distinctly laminated than such clays generally are. The clay and shale used in making brick are in a sense by-products from the stone quarry, as it is necessary to strip them off in order to work the stone. The stratum of sandstone is very persistent, being quarried in a number of places in the immediate vicinity.

26. *Huckestein Brick and Stone Co.* Office, 37 Fairmount street; yard, Nunmery Hill.—These works, which have been in operation for the past 15 years, turn out 13,000 common red brick per day, which are dried on a dry floor and burned in three up-draft kilns, each holding 250,000 brick. Natural gas is used as fuel in both dry floor and kilns. All the brick are sold in Allegheny.

Besides using clay hauled from neighboring streets which are being paved, the company uses clay and shale stripped from above the sandstone in the quarry situated directly behind the works. The sandstone is 15 feet thick and is sufficiently good to warrant its being quarried for building purposes. Upon this rests irregularly laminated, arenaceous shale, which grades into 15 feet of good but somewhat sandy clay, containing an occasional streak of red clay.

d. Allegheny River Valley.

27. *Battenfield & Schulze*. Office, 73 Grant avenue, Millvale; yard, Millvale Borough.—These works have been in operation for but one year and eighteen thousand red brick are manufactured daily. The company has three up-draft kilns, each having a capacity of 200,000. The market is entirely local.

As at most brick yards in this region, the company owns a sandstone quarry and utilizes the overburden in the manufacture of brick. The sandstone is 35 feet thick, grading at the top into eight feet of good but rather sandy yellow clay. Below the stone are 30 feet of arenaceous yellow shale, especially arenaceous near its contact with the sandstone. About 20 feet below the sandstone, imbedded in the shale, occurs a two-foot bed of badly weathered limestone. The shale is all more or less disintegrated, and together with the clay above the stone can be made into good brick.

28 and 29. *Guyasuta Brick Co., Limited*. Office, Eighteenth street and W. P. R. R., Sharpsburg.—This company operates two brick yards, one situated near the office and the other about a quarter of a mile further up the railroad. The No. 1 yard has been operated by the company for one year and for four years by other companies. The daily output is 20,000 common red and stock brick, which are dried and burned with natural gas. The three up-draft kilns in use have a combined capacity of 675,000.

The No. 2 yard was leased a year ago from Wanner and Stein, by whom it had been operated for three years. The 20,000 brick manufactured per day are burned in three up-draft kilns, holding in all 475,000. The output of both works is sold in Sharpsburg and in Pittsburgh and Allegheny, the shipping being done on the West Penn R. R.

The two yards use exactly analogous material occurring similarly in both banks and consisting of a 12-foot bed of reddish to yellowish clay which rests upon 15 feet of yellow shale, which is worthless on account of being too arenaceous. The clay is presumably of alluvial origin, having been deposited by the Allegheny river before it cut its bed down to its present level.

35. *The Kountz Brothers Co.* Office and yard, Harmarville.—This company is the only one in the county which is very actively engaged in the manufacture of paving brick. The works have been operated for about five years. The daily output is 35,000 brick, consisting of vitrified paving, common red, and dry pressed brick in varying proportion. They are dried in steam and flue dryers and are burned in 7 down-draft kilns, six holding 175,000 each, and one having a capacity of 60,000. The company finds an extensive market for its brick, shipping via the West Penn R. R. to Pittsburgh and thence on the Pennsylvania R. R. as far east as Philadelphia.

The clay and shale quarry of this company is situated in a steep hill directly behind the works. All the formations lie horizontally and conformably upon each other. The upper ten feet consist of very slightly disintegrated shale, yellowish at the top, but dark brown at the bottom, underlying which is a five-foot bed of very poor sandstone, grading at the bottom into an underlying bed of reddish yellow, arenaceous shale, 12 feet thick. Below the shale is a six-inch seam of coal underlain by ten feet of iron-stained, blue clay. All the material thus far described, with the exception of the sandstone, is made into brick, but the exposed material below the blue clay is not made use of. This material consists of 20 feet of very arenaceous shale underlain by 15 feet of argillaceous shale. The blue clay is an impure fire-clay, which burns to a reddish-buff color, owing to the small percentage of iron present. The company has experimented considerably with this clay, but has not yet been able to obtain satisfactory results.

Section of Kountz' shale quarry.

	Feet.
Slightly disintegrated shale,	10
Poor sandstone,	5
Shale,	12
Coal,	0.5
Blue clay,	10
Arenaceous shale,	20
Argillaceous shale,	15

36. *Blatchford, Meeds Brick Co.* Office and yard, Barking.*—Like Kountz Brothers, this company is one of the few in the county who have ventured into the manufacture of vitrified paving brick, 4,000 of which are made daily. An equal number of common red, stock and re-pressed brick are also made. The brick are dried in a steam tunnel and are burned in three up-draft and three down-draft kilns, having a combined capacity of 600,000. All the brick are shipped via the Allegheny Valley R. R. to Pittsburgh and intermediate points.

The shale quarry consists of 10 feet of yellowish, arenaceous shale, overlain by seven feet of alternate layers of blue and yellow shale, which are overlain by eight feet of yellowish and six feet of blue shale. Overlying the blue shale, is a poor shaly sandstone which is too arenaceous for making brick. All of this shale used is very hard and is well adapted to the manufacture of hard and durable paving brick.

37. *McFetridge Brothers.* Office and yard, Hite Station.—At this yard, only common red brick are made, the daily output being 18,000,

*Until recently this station was known as Johnston.

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Fig 56. Transporting brick to the railroad cars.

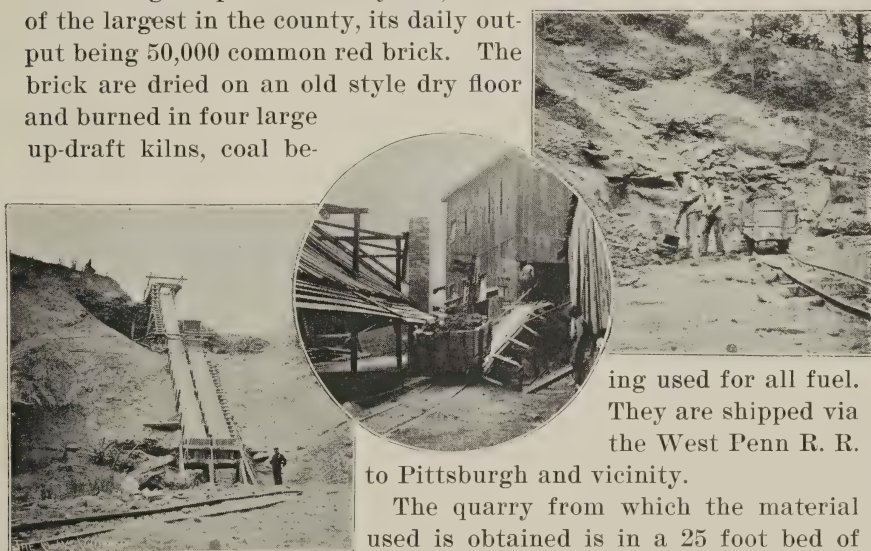


Fig. 57. Setting a kiln.

which are burned in four up-draft kilns holding 800,000 brick. The output is shipped via the West Penn R. R., principally to Natrona.

The shale and clay quarry is situated about 50 feet above the outcrop of the Freeport coal bed, the intervening material being arenaceous shale and poor sandstone. The material quarried consists of about 30 feet of yellowish and reddish shale, rather clayey in parts, especially near the top. The shale is divided into somewhat regular blocks by joint planes which extend into the hill perpendicular to the face of the quarry and to the bedding planes, making quarrying a very easy matter.

38. *Wittmer Brick Co.* Office, 12 Federal street, Allegheny; yard, Wittmer Station.—The yard of this company, which has been operated during the past thirteen years, is one of the largest in the county, its daily output being 50,000 common red brick. The brick are dried on an old style dry floor and burned in four large up-draft kilns, coal be-



ing used for all fuel. They are shipped via the West Penn R. R.

to Pittsburgh and vicinity.

The quarry from which the material used is obtained is in a 25 foot bed of slightly sandy, yellowish shale mottled irregularly with red. The shale is distinctly laminated and is separated by a marked line from the 50 feet of exceedingly arenaceous and worthless shale which underlie it.

e. Ohio Valley.

39. *Fort Pitt Stone and Brick Co.* Office, Carnegie; yard, Fort Pitt.—Up to the present time (Aug., 1897) the yard of this company has only been operated for a few weeks. Only one of the four kilns which are to be used has been completed. A steam tunnel dryer is already in use. The output, which the company predicts will be 25,000 common red brick per day, will be shipped to Carnegie, Washington, Pittsburgh and other points on the Pan Handle R. R.

Until recently, the company has only been engaged in quarrying

limestone and selling it for macadamizing roads, but so much good clay and shale must be stripped off that this material is now being made into brick. The limestone is of excellent quality, seven feet thick, and in three distinct benches. The joint planes are also very pronounced, making quarrying very easy. It is underlain by a thin seam of poor coal, and overlain by six inches of thinly laminated, iron-stained, blue shale, which crumbles to small particles when exposed to the air for a short time, and by five feet of very sandy yellow clay, which contains some gravel. The Pittsburgh coal bed outcrops less than 30 feet above the limestone.

40. Carnegie Brick Works. Office and yard, Carnegie.—The yard of this company, which has been operated for the past five years, has a daily output of 10,000 common red brick, which are dried in a steam tunnel dryer and in the open air, and are burned in three medium sized up-draft kilns, coal being used for all fuel. The market is entirely local.

With the exception of Minsinger Brothers' yard in Pittsburgh, the yard of the Carnegie Brick Works is the only one in the entire county which obtains its material for making brick from a horizon higher than that of the Pittsburgh coal bed. On the road to the works, there is an excellent outcrop of the coal bed, about 50 feet below the clay bank. The latter consists of eight feet of hard, yellowish brown clay, containing irregular gray streaks, underlain by two feet of greyish clay. About two feet below the top of the bank, occurs an irregular band of gravel, which points strongly to the fact that the neighborhood was formerly submerged in the Ohio river, or in a stream which is now extinct.

41. Penn Brick Co., L't'd. Office and yard, Leetsdale.—The daily output of this company consists of 20,000 common red and stock brick, which are dried by means of natural gas and are burned with coal in five up-draft kilns, three of which have a capacity of 250,000 each. The market is almost entirely local, but some of the brick are shipped to points on the P., Ft. W. & C. R. R.

The clay used by the Penn Brick Co., L't'd, is obtained from an alluvial flat situated 200 yards from the Ohio river and at about the present high water mark. The clay is about eight feet thick, rather sandy and decidedly homogeneous in quality. It is soft and easily worked, making it well adapted to the soft-mud machines in which it is used.

42. Harmony Brick Co. Office and yard, Leetsdale.—This yard has been operated for the past nine years by the Economite Society, of Economy, Penna., prior to which time it had been operated by other

companies for a number of years. The daily output is 20,000 common red brick, which are dried in a steam tunnel and are burned with both gas and coal in seven up-draft kilns, five of which have a capacity of 400,000 each, and the other two 125,000 each. Some of the brick are hauled to Sewickley, but the bulk of them are shipped by rail to points along the P., Ft. W. & C. R. R.

The yard of the Harmony Brick Co. is situated about three-quarters of a mile further down the Ohio river than that of the Penn Brick Co., and the clay banks of both companies are exactly similar in all respects. When the Ohio reaches its high water mark, it floods both the yard and the clay bank.

43. *Pittsburgh Brick Co.* Office, 644 Grant st., Pittsburgh; yard Briggston, P. & L. E. R. R. The yard of the Pittsburgh Brick Co. is situated about one hundred yards back from the Ohio river on the slope of the steep hill which forms the southern bank of the river at this point, on the main line of the P. & L. E. R. R. About 30,000 common red and dry pressed brick are made daily. They are dried in steam tunnels and are burned with coal in four medium-sized, up-draft kilns. The brick are shipped by rail to Pittsburgh and intermediate points.

The following table will best show the principal features of the quarry operated by the Pittsburgh Brick Co. All of the material with the exception of the ten feet of fire-clay, is in distinct horizontal laminae, and a better assortment of hard materials for making good, durable brick than is found here, could not be desired.

Quarry face of the Pittsburgh Brick Company.

	Feet.
Green arenaceous shale,	10
Blue argillaceous shale,	15
Coal,	.2
Fire-clay,	10
Hard blue shale,	10

f. Monongahela Valley.

44. *J. K. & S. D. Mills.* Office, 818 Main street, Braddock; works, Copeland Station.—Mills Brothers' yard has been in operation for only a few months (Aug. '97), and the equipment is far from being complete. A steam tunnel dryer has been erected, but no work has yet been done towards building kilns. The daily output of 10,000 will be sold in Braddock and vicinity.

The clay and shale used for making brick are the material which must be stripped from the 35-foot bed of grey sandstone which the company is quarrying. The shale grades from clay at the top into sandstone at a depth of 15 feet. The stone is of very good quality and is quite thickly bedded.

45. *Keller & Milliken.* Office and works, foot of 8th street, Braddock.—This yard, which has been operated by the present proprietors for three years, was previously operated by another company for several years. The daily output of 15,000 common red and stock brick are dried on a dry floor and burned in three up-draft kilns, coal being used for all fuel. The market is almost entirely local, but some shipping is done on the P. & L. E. R. R., the B. & O. R. R., and the P. R. R.

The clay bank from which this company obtains its clay is situated on the Monongahela river, considerably below the high water mark. The clay resembles all similarly formed river deposits, being a 15-foot bank of yellowish brown, somewhat sandy clay of homogeneous texture. It is very easily worked in a soft-mud machine.

46. *J. R. Ward & Sons.* Office, 817 Penn ave., Wilkesburg; yard, Brinton.—The Wards have been operating this yard but one year, and make when running regularly, 10,000 common red brick per day. A dry floor of the ordinary type and three medium-sized, up-draft kilns are used. The market is principally local, but some shipping is done on the Pennsylvania R. R., from which a side-track runs to the yard.

The company is operating a sandstone quarry in the hill directly behind the works, and the stripping, consisting of 12 feet of grayish-yellow, arenaceous shale disintegrated to sandy clay at the surface, is used in the manufacture of brick. The quarry consists of about 50 feet of excellent, thick-bedded, gray sandstone which is quarried and shipped to points along the railroad.

47. *J. M. Rumbaugh Brick Co.* Offices, Greensburg and Wilkesburg; yard, Pitcairn Station.—Next to Booth & Flinn, the daily output of the Rumbaugh company is the largest in the county, consisting of 50,000 common red and 10,000 dry pressed brick. They are dried on a dry floor and burned in five unusually large, up-draft kilns, coal being used for fuel. The market is along the Pennsylvania Railroad, between Pitcairn and Pittsburgh, all the shipping being done by rail. Large as the daily output is, only 40 men and boys are employed, which fact illustrates the advantage of having a yard equipped with good machinery.

The company's quarry is a 200 by 40 foot opening in the hill directly behind the works. The exposed section is as follows:

Yellowish laminated shale, 15 feet.

Dark blue shale, 5 feet.

Light blue clay, 8 feet.

Bluish sandstone, 2 feet.

Shale, bluish and reddish, 10 feet.

The blue clay burns to a buff color, but is not used alone. The sandstone is quarried and makes a good building stone. The bottom deposit of shale is variegated in color but blue prevails near the top, and red near the bottom.

48. *Keystone Brick Co., Limited.* Office and yard, Mathias avenue, near Riverton avenue, McKeesport.—This yard, which has been operated for the past five years, has a daily output of 10,000 common red and 5,000 stock brick, which are burned in three up-draft kilns of 180,000 capacity each. The market is almost entirely local and in Duquesne, but some shipping is done via the Baltimore and Ohio, Pittsburgh and Lake Erie and Pennsylvania railroads.

The quarry of this company is in a shale hill at the yard. Near the surface the shale has weathered to a reddish-brown clay, but beneath this the shale is distinctly laminated. It is blue, except where it has been exposed to the atmosphere for some time, the exposed parts being more or less red. The shale becomes more arenaceous as the depth increases.

49. *Tube City Brick Co.* Office and yard, Mathias avenue near Riverton avenue, McKeesport.—The yard of the Tube City Co. is situated near that of the Keystone Co. The daily output, consisting of 15,000 common red and 2,500 repressed brick, is burned in three up-draft kilns, each holding 225,000. The market is almost entirely local, but a little shipping is done by rail.

The shale and clay are obtained directly above that used by the Keystone Co., but the shale has disintegrated to a laminated clay to a greater degree than further down the hill. Towards the top of the quarry the shale becomes so arenaceous that it cannot be used for making brick and grades into a very good sandstone, which is being quarried by the company.

50. *Standard Brick Co.* Office, 701 Fifth avenue, McKeesport; yard, Eighth Ward, McKeesport.—Fawcett Brothers, the proprietors of this yard, have been operating it for four years. The daily output consists of 10,000 common and 9,000 dry pressed brick, which are dried on a common hot floor and burned in two small sized, up-draft kilns. The market is entirely local.

The material used by this company is very much like that used by the Tube City Co., except that the reddish brown shale has disintegrated more extensively in the quarry of the former. The face of the quarry, which is about 175 feet long and 12 feet high, shows only

occasional traces of the original shale, and the lamination is very indistinct. Although a great part of the iron has been oxidized to the ferric state, the material burns into a uniformly colored, durable brick.

51. *Glassport Brick Co.* Office, 515 Walnut street, McKeesport; yard, Pollock Station.—At this yard only common red building brick are manufactured, 15,000 of them being made daily. They are dried in a steam tunnel dryer and burned in three up-draft kilns of 220,000 capacity each. The market is local and in McKeesport. Shipping facilities are excellent, as the Pittsburgh and Lake Erie Railroad passes through the yard, and the Monongahela river is only a few hundred yards distant.

The clay and shale quarry is 100 feet long and about 20 feet deep, consisting principally of dark reddish shale, badly disintegrated to red clay, especially near the top. Several veins of yellowish clay, between six and eighteen inches thick, occur in the red clay. All of the material is easily worked and it requires but little grinding.

52. *Monongahela Brick Works*, Blair Station.—These works, which are owned by J. T. Chambers & Co., are situated between the Pittsburgh, Virginia and Charleston Railroad and the Monongahela river. The yard has been idle for more than a year and Mr. Chambers does not intend to resume operations. The yard is in very good condition, being equipped with both a soft-mud and a stiff-mud machine and five up-draft kilns, and the shipping facilities are excellent. The clay bank consists of an extensive river flat containing eight feet of good alluvial clay. It is below the high water mark.

53. *A. M. Pierce*, West Elizabeth.—Mr. Pierce's yard occupies a position exactly similar to that of the Monongahela Brick Works, and like the latter has not been in operation for several years. The equipment, consisting of an old-fashioned horse-power pug mill, molds for making brick by hand, a hot floor, and four up-draft kilns are all in very poor shape. The clay was obtained from the alluvial flat bordering on the river.

g. Youghiogheny Valley.

54. *Christy Park Brick Works*. Office and works, Christy Park Borough.—This yard has been operated for the past year by Mr. Oscar Dougherty, and by others for 12 years. Twelve to fifteen thousand common red brick are made daily, are dried on a dry floor, and are burned in two small up-draft kilns. The market is entirely local.

The clay bank is situated about 50 feet from the Youghiogheny

river, in the flat bordering on the river. The clay is very sandy and contains a considerable amount of gravel.

55. *C. M. C. Harper & Co.* Office and yard, Boston.—This yard was operated from 1885 to 1895 by Kerr & Harper, and by the present company since 1895. Fifteen thousand brick, consisting of common red, stock, hand pressed and sidewalk paving are made daily. The brick are sold in McKeesport and at various points on the Monongahela river between Pittsburgh and Belle Vernon. Shipping is done via the Youghiogheny river and the Pittsburgh and Lake Erie Railroad, both of which pass the works.

The quarry, situated in a hill about one-fourth mile behind the works, consists of 15 feet of hard, somewhat arenaceous, laminated shale overlain by four feet of yellow clay and 12 feet of yellowish brown clay. The material is hauled to the yard in wagons.

56. *Yough Brick Co.* Office, 326 Fourth avenue, Pittsburgh; Works, Greenock.—At this yard 18,000 common red, buff, and sidewalk paving brick are made daily, all of them being dry pressed. They are dried on a dry floor and burned in four up-draft kilns.

The quarry consists of three feet of worthless blue, argillaceous shale, overlain by 15 feet of hard, compact, thinly laminated "soapstone." Three or four feet of sand, clay and gravel, the remainder of a former terrace of the Youghiogheny river, overlie the soapstone.

57. *Greenock Brick Works*, Greenock.—Mr. Peckman, the proprietor of this yard, has been manufacturing soft-mud bricks for 11 years. The daily output of the yard is 18,000 common red brick, which are dried in the open air and on a dry floor and are burned in four large, up-draft kilns. The brick are shipped via the Youghiogheny river and Pittsburgh and Lake Erie Railroad to points along the Monongahela river between Pittsburgh and Belle Vernon.

The clay bank is in a ten-foot deposit of yellow, sandy clay, situated in an old river terrace.

Summary of the Brick Industry of Allegheny County.

Capital invested:

Figures sent in by 25 companies,	\$1,115,500
Estimated for remaining 27 companies,	1,096,804
Total,	<u>\$2,212,304</u>

Value of output for 1897:

Figures sent in by 25 companies,	\$551,904
Estimated for remaining 24 companies in operation,	489,971
Total,	<u>\$1,041,875</u>

Total daily capacity, bricks,	1,066,000
Total number of kilns,	199
Average number of days in operation in 1897,	280.4

The kinds of machines in use are:

Martin soft-mud machines,	21
Penfield soft-mud machines,	4
Other soft-mud machines,	5
Penfield stiff-mud, wire-cut machines,	9
Freese stiff-mud, wire-cut machines,	7
Raymond stiff-mud, wire-cut machines,	1
Dry-press machines,	5
Repress machine,	1
Hand machines,	6
Total,	59

The estimate for the capital of the companies that did not report is based on the daily capacity which is known for all. We assumed that the capital of the companies that did not report would be in the same ratio to their daily output as the capital of the companies that did report would be to their daily output, and the estimate for the production for 1897 was proportioned in the same manner.

CHAPTER IX.

STATISTICS OF THE CLAY INDUSTRY OF WESTERN PENNSYLVANIA AND ANALYSES OF THE CLAYS.

Table	I. List of the potteries and tile works.
Table	II. List of the fire brick works.
Table	III. List of the red and buff building brick works outside of Allegheny county.
Table	IV. List of red brick works in Allegheny county.
Table	V. Statistical summary of the pottery industry.
Table	VI. Statistical summary of the fire-clay industry.
Table	VII. Statistical summary of the building brick industry.
Table	VIII. Statistical summary of clay industries in Western Pennsylvania.
Table	IX. Statistical summary of clay industries in Pennsylvania for 1896.
Table	X. Statistical summary of clay industries in United States in 1896.
Table	XI. Analyses of fire-clays mined in Western Pennsylvania.
Table	XII. Analyses of fire-clays and pottery clays from different localities.
Table	XIII. Analyses of pot clays, kaolins and slip clays.

TABLE 1.

List of potteries and allied industries in Western Pennsylvania, giving name and address, kinds of clay used, kind of ware manufactured and date when started.

Locality.	Name.	Date when started.	No. of kilns.	Kind of Clay.	Kind of Products.
1. New Geneva,	C. L. Williams & Co.,	{ 1854 1857 1877 }	2	Clay from river terrace,	Blue stoneware.
2. Greensboro,	Hamilton & Jones,	{ 1857 1877 }	2	Clay from river terrace,	Blue stoneware.
3. Point Marion,	Union Pottery Co.,	1897	1	Clay from river terrace,	Blue stoneware.
4. Kittanning,	Wick China Co.,	1890	8	Clay, feldspar and flint imported,	China ware.
5. Pittsburgh,	Star Encaustic Tile Co.,	{ 1876 1887 }	2	Pittsburgh and New Brighton clays,	Floor tiling.
6. Pittsburgh,	Erb Pottery,			Pittsburgh clay,	Red flower pots.
7. Pittsburgh,	Phoenix Clay Pot Co.,			See fire clays.	
8. Pittsburgh,	Pittsburgh Clay Pot Co., New Brighton pottery, ..	1862	9	Native and imported clays,	Stoneware.
9. New Brighton,	Pittsburgh Clay Mfg. Co., Sewer Pipe Works, ..	1867	11	New Brighton clay,	Sewer pipe.
10. New Brighton,	Pittsburgh Clay Mfg. Co., Blue Lining Works, ..	1887	10	New Brighton and terrace clay,	Five lines.
11. New Brighton,	Pittsburgh Clay Mfg. Co., Oak Hill pottery,	1893	2	New Brighton clay,	Red flower pots.
12. New Brighton,	Shervette Bros.,	1878	4	New Brighton clay,	Stoneware.
13. New Brighton,	Enterprise Pottery Co.,	1881	3	New Brighton clay,	Stoneware.
14. New Brighton,	American Porcelain Co.,	1894	4	New Brighton clay,	Porcelain lined ware.
15. New Brighton,	The Beaver Valley Pottery,	1891		Now idle,	Yellow ware.
16. New Brighton,	The Fallston Pottery Co.,			Now idle,	Stoneware.
17. Fallston,	Keystone Pottery Co.,	1890-95		Now idle,	Stoneware.
18. Rochester,	The Mayer Pottery Co. (limited),	1880	5	Imported and New Brighton clays,	Ironstone china ware.
19. Beaver Falls,	The Beaver Falls Art Tile Co.,	1887	5	New Brighton and imported clays,	Decorative tile.
20. Beaver Falls,					

TABLE II.

Showing the name and address of fire brick manufacturers in Western Pennsylvania, capacity of works, kind of material used, kind of ware manufactured, and date when started.

Location.	Name of Company.	When started.	Capacity per day.	No. of kilns.	Kind of Materials Used.	Products.
ALLEGHENY VALLEY.						
1. Manorville,	Phoenix Fire Brick Works,	{ 1864 1896 1879 }	23,000	6	{ Sandstone and lime, Flint and plastic fire clay,	Silica brick. Fire brick.
2. Cowanshannoc,	Phoenix Fire Brick Works,			6		
KISKIMINUITAS AND CONEMAUGH VALLEYS.						
4. Black Lick,	Kier Brothers,	1845	14,000	7	Flint and plastic clay,	Fire brick.
5. Bolivar,	The Burl Fire Brick Co.,	{ 1867 1876 1879 }	20,000	4	Flint, plastic clay and ganister,	Fire, building, paving and silica brick.
6. Bolivar,	Reese, Hammond & Co.,	1859	65,000	20	Flint, plastic clay and ganister,	Fire, building, paving and silica brick.
7. Bolivar,	Geiseld Fire Clay Co.,	1859	20,000	4	Flint and plastic clay,	Fire brick, sp. locomotive tiling.
8. Lockport,	Lincoln Fire Brick and Shape Co.,	1872	20,000	4	Flint and plastic clay,	Not in operation.
9. Lockport,	Jas. Gardner, Jr.,	1863	10,000	3	Flint and plastic clay,	Gas retorts etc.
10. Johnstown,	A. J. Haws & Son,	1859	57,000	17	Flint, plastic clay and ganister,	Fire brick and silica brick.
11. Johnstown,	M. L. Williams & Co.,	1856	5,000	4	Flint, plastic clay and ganister,	Fire brick.
12. Kingston,	Hiram Svank & Sons,	1896	5,000	3	Ganister and lime,	Silica brick.
13. Hunker Station,	The Wm. Stuart Silica Brick Co.,	1891	20,000	1	Hard and soft fire clay,	Not in operation in 1897.
YOUGHIOGHENY RIVER VALLEY.						
14. Layton Station,	Layton Fire Clay Co.,	1890	30,000	6	Hard and soft fire clay,	Fire, paving and building brick.
15. Layton Station,	Stuart Fire Brick Co.,	1898	8,000	4	Ganister, lime, soft clay and blue clay,	Silica and sand brick.
16. Layton Station,	Silica Brick Co.,	1896		3		Not in operation.
17. Lavenia Station,	Crescent Fire Brick Co.,		20,000	5	Flint and plastic clay and shale,	Not in operation.
18. Connellsville,	Joseph Solsson Fire Brick Co.,	{ 1864 1871 1878 }	20,000 11,000 30,000	5 5 5		Fire, building and paving brick, three yards.
19. Dunbar,	Dunbar Fire Brick Co.,	1863	20,000	7	Hard and soft fire clay,	Fire, building and paving bricks.
20. Mt. Braddock,	Eureka Fire Brick Works,	1872	12,000	2	Fire clay,	Fire brick and paving brick.
21. Lemont,	McClure Coke Co.,		9,000	4	Fire clay,	Fire brick.

MONONGAHELA VALLEY.									
22.	Courtney,	John Tempest & Co.,	1890	5,000	8	Fire clay,	.....	Pipe shapes,	fire bricks.
23.	Manowal,	Tempest Fire Brick Co.,	1892	10,000	14	Fire clay,	.....	Pipe shapes,	fire bricks.
24.	Manowl,	The Manown Manufacturing Co.,	1895	15,000	8	Fire clay,	.....	Pipe shapes,	fire bricks.
OHIO VALLEY.									
25.	Monaca,	Welch, Gloninger & Co.,	1881	20,000	11	Fire clay,	.....	Fire brick.	
26.	Beaver,	The Stahl Fire Brick Co.,	1848 } 1887 }	8,000	4	Fire clay,	.....	Fire brick.	
27.	Vanport,	Welch, Gloninger & Co.,	1886	12,000	3	Fire clay,	.....	Fire brick and building brick.	
28.	Mahan,	Park Fire Clay Co.,	1889	20,000	7	Fire clay,	.....	Not in operation in 1897.	
29.	Rochester,	S. Barnes & Co.,	1889	8,000	3	Fire clay,	.....	Fire brick and stove linings.	
30.	New Brighton,	Ingram & Co.,	1895	30,000	6	Fire clay,	.....	Fire brick.	
31.	New Brighton,	A. F. Smith & Son,	1887 }					Fire brick, fire-clay and potter's clay.	
32.	Pittsburgh,	Harbison & Walker,	1885	60,000	73	Fire clay,	.....	Fire brick.	
33.	Pittsburgh,	Iron City Fire Brick Co.,	1885	3,000	9	Fire clay,	.....	Fire brick; recently removed to Sandy Ridge.	
34.	Pittsburgh,	Pittsburgh Clay Pot Co.,	.....		2	Fire clay,	.....	Glass pots.	
35.	Pittsburgh,	Phoenix Clay Pot Works,	.....			Fire clay,	.....	Glass pots, tank and furnace blocks.	
THE FOLLOWING MINE AND SHIP FIRE CLAY BUT HAVE NO WORKS.									
36.	G. Dando & Brother,	Freedom,	.....			Ground fire clay.			
37.	David Coulter,	Boltivar,	.....			Fire clay for gas retorts.			
38.	D. H. Emme,	White House,	.....			Glass pot clay.			
39.	Kennedy & McFarlane,	Ohio Pyle,	.....			Flint fire clay.			
40.	Mr. Paul,	Stewarton,	.....			Flint fire clay.			
41.	Mrs. M. J. Wurm,	Layton Station,	.....			Glass pot clay.			
42.	D. B. Wilson,	Mineral Point,	.....			Flint fire clay.			
43.	D. D. Page,	South Fork,	.....			Flint fire clay.			

*Two car loads.

†A continuous chambered kiln.

TABLE III.

List of manufacturers of red and buff building brick in Western Pennsylvania, showing capacity of the works, number of kilns, kinds of clay, kinds of brick produced and date when started.

Locality.	Name of Company.	Date.	Capacity per day.	No. of kilns.	Kinds of Clay.	Kinds of Brick.
BUFF AND ORNAMENTAL BRICK.						
1. Fallston,	Fallston Fire Clay Co.,	1891	20,000	12	Plastic fire clays,	Buff and colored building, paving and fire brick.
2. Monaca,	Welch, Gloninger & Co.,	1881	20,000	1	See fire brick.	Buff and colored building, paving and fire brick.
3. Vanport,	Vanport Brick Co.,	(1897) 1896	20,000 30,000	5 6	Plastic fire clay,	Building brick, paving brick and Buff and colored building brick.
4. Kittanning,	Kittanning Clay Manufacturing Co.,	1894	30,000	10	Plastic fire clay,	Buff and colored building brick.
5. Kittanning,	Kittanning Brick and Fire Clay Co.,	1882	15,000	4	See fire brick.	Red and buff building and paving brick.
6. Layton Station,	Reese, Hammond & Co.,	1888	15,000	3	See fire brick.	Not in operation.
7. Fairport,	Layton Brick Co.,	1892	15,000	2	Clay and shale,	Red building brick.
8. Fairport,	Fairchance Lumber and Brick Co.,	(1897) 1888	10,000 15,000	4 3	Shale and clay,	Red building and paving brick.
9. Freeport,	John Coward,	1888	15,000	2	Shale,	Red building brick.
10. Ford City,	The Manor Brick Co.,	1892	15,000	3	Clay,	Red building brick.
11. Hyde Park,	Kuhn & Schaeffer,	1890	10,000	4	Shale,	Red building and ornamental brick.
12. Blairsville,	J. D. Neff Brick Co.,	(1897) 1888	10,000 70,000	4 4	Shale,	Red building and ornamental brick.
13. Blairsville Intersection, ..	Branch Brick Co.,	1889	18,000	2	See Allegheny county,	Red building brick.
14. Sheridan,	Louis Whelan, Co.,	1884	1,000	2	Shale,	Red building brick.
15. Johnstown,	Cambridge Iron Works,	1884	30,000	3	Clay,	Red building brick.
16. Irwin,	J. M. Rumbaugh Brick Co.,	1896	30,000	4	Shale,	Red building and ornamental brick.
17. Plumet,	J. M. Rumbaugh Brick Co.,	1888	70,000	4	Shale,	Red building and ornamental brick.
18. Plumet (Wall),	Standard Brick Co.,	1889	18,000	2	Shale,	Red building brick.
19. Greensburg,	W. W. Parks,	1889	7,000	2	Shale,	Red building and pressed brick.
20. Greensburg,	John Robb,	1877	3,000	2	Aluminum,	Red building brick, hand made.
21. Mt. Pleasant,	Chas. Hays,	1879	10,000	3	Aluminum,	Red building brick.
22. West Newton,	John F. Cruthers,	1880	20,000	2	Aluminum,	Red building brick.
23. West Newton,	F. A. Humphrey,	1890	20,000	1	Shale,	Red building brick.
24. Dawson,	F. G. Smith,	1896	8,000	2	Aluminum,	Red building brick.
25. Connellsville,	Soisson & Scholsser,	1896	8,000	1	Clays,	Red building brick.
26. Connellsville,	Bird & Fancher,	1897	4,000	1	Terrace clay,	Red building brick, hand made.

23. Uniontown,	J. V. Williams & Co.,	{ 1847 1857 }	40,000	3	Surface clay,	Red building brick.
29. Uniontown,	W. L. Robinson,	1858	10,000	3	Surface clay.	Red building brick.
30. Fairchance,	Fairchance Lumber and Brick Co.,	1858	10,000	3	Surface clay.	Red building brick.
31. Fairchance,	Fairchance Brick and Tile Co.,	1857	15,000	2	See buff brick.	Red building brick.
32. Uniontown,	A. J. Hayden,	1857	3,000	2	Surface clay,	Red building brick.
33. Uniontown,	J. T. Matthews,	1857	3,000	1	Surface clay,	Red building brick.
34. Uniontown,	Uniontown Brick Co.,	1857	5,000	2	Alumnum,	Red building brick.
35. Fayette City,	The Charlotte Brick Co.,	1852	2,000	3	Red yellow clay,	Red building brick.
36. Fayette City,	Dinsmore Bros.	1852	10,000	2	Shale and fire clay,	Red building and fire brick.
37. California,	F. H. Martin,	1852	10,000	2	Alumnum,	Red building brick.
38. New Brighton,	A. Dewhirst & Bro.,	1874	10,000	2	Terrace clay,	Red building brick.
39. Rochester,	Park Fire Clay Co.,	1874	10,000	2	Terrace clay,	Red building brick.
	Freedom, two yards,		90,000	47		
	Monaca,		25,000	40		
	Fallston,		20,000	12		
					Lower Kittanning fire clay, ...	Paving and building brick.

*The Park Fire Clay Co. would give no information. The figures are estimates by the writer, except the kilns, which were counted.

TABLE
The Brick Yards of

No.	Name of company.	Office address.	Location of yard.
a. PITTSBURGH BRICK YARDS.			
1	R. Knowlson & Son,	At yard,	325 Vickroy street,
2	Boyd Hill Brick Co.,	At yard,	Vickroy and Magee streets, ...
3	Booth & Flinn,	1942 Forbes street, ..	Ruch's Hill,
3a.	Pittsburgh Terra Cotta Lumber Co.,	At yard,	Bedford avenue,
4	Albert Neely,	At yard,	Tustin and Jumonville streets, ..
5	American Clay Manufacturing Co., ..	At yard,	Frazier and Griffith streets, ...
6	Mrs. A. M. Entress,	At yard,	Webster and Lawson streets, ...
7	Harblson & Walker,	At yard,	Twenty-second st. & A. V. R. R.,
8	W. and J. Francies,	At yard,	Liberty avenue and 34th street,
9	Evan Jones,	Carnegie building, ..	Liberty avenue and 36th street,
10	Hooper Bros.,	At yard,	Bellefield and Centre avenues,
11	Blair Bros.,	At yard,	Edmond street near Liberty ave.,
12	Sankey Bros.,	2101 Carson st., S. S.,	Atlantic avenue, E. E.,
13	Iron City Brick and Stone Co., .	At yard,	Stanton ave. & McCandless st.,
14	Thos. Marshall,	5020 Cypress st., E. E.,	Kelly street, E. E.,
15	Jno. W. Beckett,	At yard,	Hamilton & Dallas aves., E. E.,
b. SOUTH SIDE BRICK YARDS.			
16	West End Brick and Stone Co., ..	121 Wabash avenue,	Thirty-fifth ward,
17	Minsinger Bros.,	At yard,	Prospect street, 32d ward,
18	Knoxville Land Improvement Co.,	86 Knox avenue,	Knoxville borough,
19	Sankey Bros.,	2101 Carson street,	S. Eighteenth street,
20	J. & H. Benz,	At yard,	S. 18th st. and Quarry Road,
21	Keeling Brick Co.,	2014 Josephine street,	Quarry Road,
22	M. Lanz & Sons,	S. 29th & Carson sts.,	S. Thirty-fourth street,
23	S. S. Brick and Stone Co., Ltd., ..	At yard,	S. Thirty-third street,
c. ALLEGHENY BRICK YARDS.			
24	Geyer Bros.,	At yard,	Woodland avenue,
25	Miller Bros.,	At yard,	Charles street,
26	Huckestein Brick and Stone Co.,	87 Fairmount st.,	Nunnery Hill,
d. ALLEGHENY VALLEY BRICK YARDS.			
27	Battenfield & Schulze,	73 Grant avenue,	Millvale borough,
28	Guyasuta Brick Co., Ltd., No. 1,	18th st. & W.P.R.R.,	Sharpsburg,
29	Guyasuta Brick Co., Ltd., No. 2,	18th st. & W.P.R.R.,	Sharpsburg,
35	Kountz Bros. Co.,	At yard,	Harmarville,
36	Blanchford, Meeds Brick Co.,	At yard,	Barking Station,
37	McFetridge Bros.,	At yard,	Hite Station,
38	Wittmer Brick Co.,	12 Federal street, Al- legHENY,	Wittmer Station,
e. OHIO VALLEY BRICK YARDS.			
39	Ft. Pitt Stone and Brick Co.,	Carnegie,	Ft. Pitt,
40	Carnegie Brick Co.,	At yard,	Carnegie,
41	Penn Brick Co., Limited,	At yard,	Leetsdale,
42	Harmony Brick Co.,	At yard,	Leetsdale,
43	Pittsburgh Brick Co.,	644 Grant st., Pitts- burgh,	Briggston,
f. MONONGAHELA VALLEY BRICK YARDS.			
44	J. K. & S. D. Mills,	818 Main st., Brad- dock,	Copeland Station,
45	Keller & Milliken,	Elighth street,	Braddock,
46	J. R. Ward & Sons,	817 Penn avenue, Wilkinsburg,	Brinton,
47	J. M. Rumbaugh Brick Co.,	[Greensburg,] [Wilkinsburg,]	Pitcairn,
48	Keystone Brick Co., Limited,	At yard,	McKeesport,
49	Tube City Brick Co.,	At yard,	McKeesport,
50	Standard Brick Co.,	701 Fifth avenue, ...	McKeesport,
51	Glassport Brick Co.,	515 Walnut st., Mc- Keesport,	Glassport,
52	Monongahela Brick Works,	At yard,	Blair Station,
53	A. M. Pierce,	W. Elizabeth,	W. Elizabeth,
YOUGHIOGHENY VALLEY BRICK YARDS.			
54	Christy Park Brick Works,	At yard,	Christy Park borough,
55	C. M. C. Harper & Co.,	At yard,	Boston,
56	Yough Brick Co.,	326 Fourth avenue, Pittsburgh,	Greenock Station,
57	Greenock Brick Works,	At yard,	Greenock Station,

IV.

Allegheny County.

When started.	Months operated in 1897.	Men and boys.	Kilns.	Capacity per day.	Material used.	Products.
1845	5	27	4	15,000	Clay and shale,	Common red brick.
1885	.....	35	4	20,000	Clay and shale,	Common red brick.
1889	12	120	10	125,000	Clay and shale,	Common red and stock brick.
.....	.....	60	.....	*35,000	Clay and shale,	Terra cotta lumber.
1875	.....	5	3	5,400	Clay,	Common red brick.
1896	12	20	3	30,000	Clay and shale,	Common, vitrified, pressed brick.
1882	10	25	3	20,000	Clay and shale,	Common red and stock.
1894	10	36	4	20,000	Clay and shale,	Fire brick.
.....	.....	14	3	15,000	Clay and shale,	Common red and stock brick.
1890	.....	14	3	15,000	Clay and shale,	Common red brick.
1885	11	32	5	16,000	Clay,	Common red and stock brick.
1880	11	25	4	15,000	Clay,	Common red and stock brick.
1891	.....	18	4	15,000	Clay and shale,	Common red brick.
1894	6	11	3	6,700	Clay,	Common red brick.
1877	9	30	4	15,000	Clay,	Common red and stock brick.
1894	.....	23	3	16,000	Clay and shale,	Common red brick.
1886	3	17	3	10,000	Clay and shale,	Common red brick.
1881	9	20	4	10,000	Clay and shale,	Common red and stock brick.
1866	12	35	6	20,000	Clay and shale,	Common, stock, pressed brick.
1882	.....	25	4	15,000	Clay and shale,	Common red brick.
1887	8	25	5	15,000	Clay and shale,	Common red brick.
1887	11	20	5	20,000	Clay and shale,	Common, stock, buff & pressed brick.
1890	9	32	5	17,000	Clay and shale,	Common red and stock brick.
1882	.....	16	3	7,000	Clay,	Common red brick.
1891	10	30	4	25,000	Clay and shale,	Common red brick.
1882	Idle.	.....	3	13,000	Clay and shale,	Common red brick.
1896	.....	15	3	18,000	Clay and shale,	Common red brick.
1896	.....	30	3	20,000	Clay,	Common red brick.
1896	.....	25	3	20,000	Clay,	Common red brick.
1892	4	40	7	35,000	Clay and shale,	Paving, pressed and common brick.
1893	.....	26	6	16,000	Clay and shale,	Com., repressed, paving & stock br.
1884	12	24	4	18,000	Clay and shale,	Common red brick.
1884	.....	50	4	50,000	Clay and shale,	Common red brick.
1897	4	15	1	25,000	Clay and shale,	Common red brick.
1892	5	13	3	10,000	Clay,	Common red brick.
1892	9	34	5	20,000	Clay,	Common red and stock brick.
1887	8	27	7	20,000	Clay,	Common red brick.
1894	.....	22	4	30,000	Clay and shale,	Common red and pressed brick.
1897	2	10	2	.....	Clay and shale,	Common red brick.
1891	.....	24	3	15,000	Clay,	Common red and stock brick.
1896	.....	10	3	10,000	Clay and shale,	Common red brick.
1892	.....	40	5	60,000	Clay and shale,	Common red and pressed brick.
1892	.....	24	3	15,000	Clay and shale,	Common red and stock brick.
1892	.....	18	3	15,000	Clay and shale,	Common red and repressed brick.
1893	5	14	2	10,000	Clay and shale,	Common red and dry repressed brick.
.....	.....	23	3	15,000	Clay and shale,	Common red brick.
.....	Idle.	.....	5	50,000	Clay,	.....
.....	Idle.	.....	4	.....	Clay,	.....
1887	1	11	2	12,000	Clay,	Common red brick.
1885	.....	23	3	15,000	Clay and shale,	Common red and stock brick.
.....	4	12	4	18,000	Clay and shale,	Common, dry pressed, stock & buff br.
1886	.....	16	4	18,000	Clay,	Common red brick.

*Tons per year.

TABLE V.

Statistical summary of the fire-clay industry in western Pennsylvania.

Capital invested in the pottery business,	\$1,010,840
Value of the output for 1897,	713,251
Value of the output for 1896,	642,240
Number of men employed in 1897,	928
Number of companies in 1897,	14
Number of kilns in 1897,	71

The above includes the output from all the stoneware potteries (6), the earthenware (2), the china and whiteware (2), encaustic and enameled tile works (2), one hollowware company, one sewer-pipe works and one flue-lining factory.

TABLE VI.

Statistical summary of the pottery industry in western Pennsylvania:

1. Capital invested in 1897,	\$3,179,817
17 companies reported,	2,504,863
Estimate for 9 companies who did not report,	674,954
2. Value of the output for 1897,	1,485,748
17 companies reported,	1,285,748
Estimate for the 9 companies failing to report,	200,000
3. Value of output for 1896,	1,591,916
17 companies reported,	1,351,916
Estimate for 9 other companies,	210,000
4. Number of men employed in 1897,	1,624
5. Capacity of works per day in fire brick,	497,000
6. Number of companies or individuals who mine clay, but do not manufacture,	10
Number of kilns,	271
7. Estimated value of fire-clay mined and sold, not in- cluded in No. 2,	\$40,000
8. Estimated value of the glass pots and gas retorts pro- duced in 1897,	300,000
9. Value of the output of all the fire-clay products in the river valley regions of western Pennsylvania for 1897,	1,825,748
10. Value of the fire brick produced in Pennsylvania for 1896,	2,083,414
11. Value of the fire brick produced in U. S. for 1896,	4,906,923

TABLE VII.

Statistical summary of the building brick industry in the river valley regions of western Pennsylvania:

Capital invested,	\$2,644,954
Buff and ornamental brick,	183,000
Red brick outside of Allegheny county,	249,650
Red brick in Allegheny county,	2,212,304
Value of the output for 1897,	1,411,130

Buff and ornamental brick,	155,500
Red brick outside of Allegheny county,	213,755
Red brick in Allegheny county,	1,041,875
Value of the output for 1896:	
Buff and ornamental brick,	111,000
Red brick outside of Allegheny county,	151,713
Red brick in Allegheny county,	
Number of men employed in 1897,	1,733
Buff and ornamental brick,	134
Red brick outside of Allegheny county,	384
Red brick in Allegheny county,	1,215
Number of kilns in use,	304
Daily capacity,	1,615,000
Outside of Allegheny county,	549,200
In Allegheny county,	1,066,000
Number of brick companies operating works in 1897,	89
Outside of Allegheny county,	37
In Allegheny county,	52

TABLE VIII.

Statistical summary of the clay industries in the river valleys of western Pennsylvania.

Item.	Potteries.	Fire brick.	Building brick.	Total.
Capital invested in 1897,	\$1,010,840	\$3,179,817	\$2,644,954	\$6,835,611
Value of the output for 1897,	713,251	1,485,748	1,411,130	3,610,129
Daily capacity in bricks,	497,000		1,615,000	2,112,000
Number of companies,	14	36	89	139
Number of kilns,	71	271	373	715
Number of men employed,	928	1,624	1,851	4,403

The above figures do not include the output or capital of the Park Fire Clay Co., nor of one of the glass-pot companies, nor the glass pots manufactured by the glass companies, nor the gas retort works at Lockport, all of which would probably bring the total invested capital to seven million dollars or more, and the value of the output to nearly four million dollars. It may be interesting to compare the following statistics for the whole state, which are copied from the mineral resources of the United States, published by the United State Geological Survey.

TABLE IX.

Statistical summary of the clay industries in Pennsylvania for the year 1896.*

Value of all the clay products in Pennsylvania produced in 1896,	\$9,063,313
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*Compiled from the Min. Resources in the 18th An. Rept. U. S. Geol. Surv. The returns for 1897 are not yet available.

Value of the common brick produced in 1896,	4,118,206
Value of the fire brick,	2,083,414
Value of the pressed brick produced in 1896,	662,188
Value of the paving brick produced in 1896,	404,182
Value of the fancy brick produced in 1896,	30,545
Value of the drain tile produced in 1896,	49,039
Value of the pottery produced in 1896,	617,601

TABLE X.

Value of the clay products of the United States in 1896.*

State.	Fire brick.	Total brick and tile.	Total pottery.	Grand total.
Alabama,	\$900	\$365,760	\$6,425	\$372,185
Arizona,		55,663		55,663
Arkansas,	2,000	193,532		216,332
California,	10,336	663,155	17,022	680,207
Colorado,	42,264	328,680		328,680
Connecticut,	64,000	1,102,898	48,700	1,151,598
Delaware,		61,003		61,003
District of Columbia,		350,565	3,000	353,565
Florida,		119,844	2,306	122,144
Georgia,	29,950	897,653	7,160	904,813
Idaho,		16,000		16,000
Illinois,	117,040	5,441,765	421,482	5,863,247
Indiana,	12,510	2,545,980	128,845	2,674,325
Iowa,	5,920	1,901,623	43,035	1,944,658
Kansas,	27,000	252,837	7,250	260,087
Kentucky,	126,539	735,069	95,750	830,809
Louisiana,	50	401,812	600	402,412
Maine,	37,501	956,681	250	956,931
Maryland,	232,270	1,422,359	27,696	1,450,055
Massachusetts,	187,710	2,056,631	206,343	2,262,974
Michigan,	3,575	985,255	20,150	1,005,405
Minnesota,	2,000	555,265	41,436	596,701
Mississippi,	3,300	223,809	1,000	224,809
Missouri,	484,415	2,629,312	50,933	2,680,245
Montana,	69,035	276,311		276,311
Nebraska,		144,373		144,373
New Hampshire,	12,400	581,169	17,000	598,169
New Jersey,	458,825	3,658,861	1,069,142	4,728,003
New York,	302,407	6,102,473	311,733	6,414,206
North Carolina,	6,140	408,544	14,955	423,499
North Dakota,		59,625		59,625
Ohio,	696,175	7,050,221	2,899,350	9,949,571
Oklahoma,†		38,444		38,444
Oregon,	15,248	118,545	7,800	126,345
Pennsylvania,	2,260,790	8,445,712	617,601	9,063,313
Rhode Island,	3,000	297,000		297,000
South Carolina,	19,750	353,175	1,100	354,275
South Dakota,		53,004		53,004
Tennessee,	24,956	499,664	37,661	537,325
Texas,	7,060	857,672	53,081	915,753
Utah,	5,750	137,573		137,573
Vermont,		83,274		83,274
Virginia,	1,750	869,086	10,440	879,526
Washington,	12,500	160,348	1,180	161,528
West Virginia,	4,000	492,237	410,707	902,944
Wisconsin,	1,200	760,785	12,500	773,285
Wyoming,		9,659		9,659
United States,	\$5,279,004	\$55,721,226	\$6,620,627	\$62,341,853
Per cent. of total,	8.08	89.38	10.62	100.00

*From the Eighteenth Annual Report U. S. Geol. Survey, Pt. V (cont'd), p. 1077.

†Including Indian Territory and New Mexico.

TABLE XI.
Analyses of fire-clays mined in western Pennsylvania.

Locality.	Silica. SiO ₂ .	Alumina. Al ₂ O ₃ .	Iron oxide. FeO.	Titanic oxide. TiO ₂ .	Lime. CaO.	Magnesia. MgO.	Alkalies. Na ₂ O. K ₂ O.	Water. H ₂ O.	Authority.
1. Bolivar, E. Robinson, flint clay,	50.840	30.745	3.213	1.260	.160	.288	.541	13.050	2d Pa. Geol. Surv., H ₄ , p. 32.
2. Bolivar, E. Robinson, plastic clay,	53.830	24.580	1.655	1.170	.280	.872	3.114	(3) 9.792	2d Pa. Geol. Surv., H ₄ , p. 32.
3. Bolivar, E. Robinson, flint clay,	63.81	26.39	(4) 1.23	.....	tr.	tr.	.....	9.390	State College chem. laboratory.
4. Black Lick, E. J. Meldren, flint clay, ..	63.430	18.490	1.692	2.850	.110	.351	.296	6.310	2d Pa. Geol. Surv., H ₄ , p. 32.
5. Black Lick, E. J. Meldren, plastic clay, ..	63.430	18.490	1.692	2.850	.280	.551	2.755	13.695	2d Pa. Geol. Surv., M. M., p. 259.
6. Salina, Kier Bros., flint clay, top layer, ..	47.250	34.350	6.93	1.990	.580	.090	.261	7.495	2d Pa. Geol. Surv., M. M., p. 259.
7. Salina, Kier Bros., plastic clay,	55.330	27.841	2.916	1.140	.580	.756	3.916	12.490	2d Pa. Geol. Surv., M. M., p. 260.
10. Laughlinstown, Robt. Hall, flint clay, ..	55.680	29.180	.837	1.490	.130	.180	.245	8.380	2d Pa. Geol. Surv., M. M., p. 260.
11. Jacob's Creek, "furnace clay," plas. clay, ..	56.780	26.890	.322	.....	.369	.987	3.920	13.790	2d Pa. Geol. Surv., M. M., p. 260.
12. Jacob's Creek, "forge clay," flint clay, ..	65.370	24.870	.756	.....	.168	.234	.010	8.790	2d Pa. Geol. Surv., M. M., p. 260.
13. Choptie, Geo. Potter, flint clay,	52.230	31.310	1.008	1.680	.130	.165	.720	13.190	2d Pa. Geol. Surv., M. M., p. 260.
14. South Fork, flint clay,	43.460	41.610	(4) 1.030	.....	.240	.090	.....	(3) 13.290	Pa. State College chem. lab.
15. Kittanning, "furnace clay,"	60.400	26.230	.230	(6)	.140	.540	2.40	(3) 9.790	Pa. State College chem. lab.
16. Kittanning, "furnace clay,"	54.330	32.800	.210	(6)	.410	.190	1.03	(3) 11.940	Pa. State College chem. lab.
17. White House, glass-pot clay,	54.230	32.800	.210	.....	.440	.522	1.750	8.850	2d Pa. Geol. Surv., M. M., p. 262.
18. New Brighton, El. & Sher., No. 1 grade, ..	61.970	22.940	1.818	1.975	.455	.353	2.418	7.680	2d Pa. Geol. Surv., M. M., p. 262.
19. New Brighton, El. & Sher., No. 2 grade, ..	61.750	23.660	1.830	1.780	.470	.309	1.977	7.640	2d Pa. Geol. Surv., M. M., p. 262.
20. New Brighton, El. & Sher., raw,	62.260	23.890	1.408	1.730	.470	.309	1.977	7.640	2d Pa. Geol. Surv., M. M., p. 262.
22. New Brighton, Sherwood Bros.,	63.55	24.83	1.17	.....	.56	.470	2.27	6.95	Ohio Geol. Surv., Vol. VII, p. 34.
23. New Brighton, Mend. & Chamb.,	66.610	18.930	1.964	2.810	.490	.547	1.079	7.495	2d Pa. Geol. Surv., M. M., p. 262.
25. New Brighton, Couch's clay,	57.670	27.520	1.494	2.540	.380	.122	.619	9.680	2d Pa. Geol. Surv., M. M., p. 262.
26. New Brighton, Fish estate,	66.700	22.870	1.280	(7)	.420	.520	1.322	6.83	Pa. State College Chem. Lab.
27. Noncheste, Pa., "furnace clay,"	61.190	24.230	1.697	2.890	.380	.137	1.867	9.400	2d Pa. Geol. Surv., M. M., p. 262.
28. Noncheste, Severn's clay,	61.190	24.230	1.697	2.890	.380	.137	1.867	9.400	2d Pa. Geol. Surv., M. M., p. 262.
31. Layton, J. S. Wilgus,	57.430	26.050	1.629	1.330	.580	.980	4.537	7.930	2d Pa. Geol. Surv., M. M., p. 267.
32. Connellsville, J. Soisson & Co.,	56.885	28.250	1.810	1.500	.280	.136	.638	12.230	2d Pa. Geol. Surv., M. M., p. 267.
33. Moyer, J. Soisson & Co.,	55.280	34.170	2.210	.....	1.370	2.110	.....	.....	J. H. Cremer.
34. Bailey Point, J. Soisson & Co.,	60.800	28.100	.450	.....	.240	.090	.300	9.600	Min. Res. U. S., 1896, p. 55.
36. Brady's Run, B. R. Fire Brick Co.,	63.92	22.38	.980	.....	.19	.12	.....	6.14	Manown Manufacturing Co.
37. Manown, Pa.,	64.17	29.75	2.600	.....	.40	.12	.....	.....	Westmoreland Fire Brick Co.
38. Hunker Station, Pa.,	41.75	40.09	.65	.....	.03	1.02	.....	13.20	Queen's Run Fire Brick Co.
39. Queen's Run, Pa.,	50.80	32.28	1.77	.....	.06	.47	4.56	8.94	Queen's Run Fire Brick Co.

(5) Fe₂O₃ equals 1.34.(6) Fe₂O₃ equals 0.29.(7) Fe₂O₃ equals 1.12.

compare with Nos. 4-12 in the following table.

TABLE XII.
Analyses of fire-clays and pottery clays.

No.	Locality.	Silica.	Alumina.	Fertile oxide.	Lim.	Magnesia.	Alkalies.	Water.	Authority.
FIRE-CLAYS.									
1	Black Rock, Arkansas.	34.24	11.50	.08	.52	.02	.42	3.98	Jour. Chem. Soc., Vol. 17.
2	Golden, Colorado.	43.54	34.04	.88	.61	.36	1.31	13.91	Solden Pressed and Fire Brick Co.
3	Frushing, Michigan.	53.50	21.50	3.70	1.39	1.36	1.65	.....	Saginaw Clay Manufacturing Co.
4	Texico, Missouri.	53.77	30.50	3.70	1.39	.82	.49	12.68	Mo. Geol. Surv., Vol. XI, p. 563.
5	High Hill, Missouri.	47.30	37.74	1.48	.57	.32	.50	12.75	Mo. Geol. Surv., Vol. XI, p. 563.
6	High Hill, Missouri.	45.12	40.40	.47	.29	tr.	.30	13.34	Mo. Geol. Surv., Vol. XI, p. 566.
7	St. Louis, Missouri.	61.73	23.55	.52	.55	.15	1.00	9.25	Mo. Geol. Surv., Vol. XI, p. 563.
8	Millville, New Jersey.	77.45	15.65	.....	tr.	.75	.....	5.35	H. Burden.
9	South Amboy, New Jersey.	61.76	26.14	.....	.80	.....	.....	9.60	H. Burden.
10	Woodbridge, New Jersey.	75.74	18.34	.....	.06	.66	.....	4.58	H. Burden.
11	Massillon, Ohio.	61.58	24.14	1.20	.45	.70	.....	11.93	Massillon Stone and Fire Brick Co.
12	Rapid City, South Dakota.	87.05	6.56	1.64	.95	1.24	3.71	.....	Ed. C. Smith.
13	Mt. Savage, Maryland.	44.00	38.53	1.15	tr.	.11	.20	11.57	Ed. C. Smith.
14	Mt. Savage, Maryland.	56.80	32.68	1.15	.....	.80	1.80	10.50	Ed. C. Smith.
15	New Castle, Ohio.	56.49	28.83	2.46	.26	.08	1.37	11.38	G. H. Cook, Clays of N. J., 1877.
POTTERY CLAYS.									
1	Huntingburg, Indiana.	69.23	18.97	0.55	0.12	.36	2.60	5.46	Ind. Geol. Survey, 20th, p. 109.
2	Guthrie, Missouri.	48.82	32.90	3.10	.40	.30	.82	13.58	Mo. Geol. Surv., XI, p. 563.
3	Calhoun, Missouri.	71.94	17.60	2.35	.62	.56	1.50	5.27	Mo. Geol. Surv., XI, p. 564.
4	Field's Creek, Missouri.	55.39	25.79	4.83	.52	.81	3.39	8.60	Mo. Geol. Surv., XI, p. 564.
5	De Soto, Missouri.	49.04	34.55	.71	1.33	1.04	.85	12.33	Mo. Geol. Surv., XI, p. 566.
6	Kreischersville, New York.	64.26	24.76	.43	.15	tr.	2.53	.....	Mo. Geol. Surv., XI, p. 566.
7	Northport, Long Island.	58.84	23.40	1.18	.....	.....	5.38	9.20	Clay Industries of N. Y., 1895.

TABLE XIII.

Analyses of glass-pot clays, kaolins and slip clays.

No.	Locality.	Silica.	Alumina.	Iron oxide.	Lime.	Magnesia.	Alkalies.	Water.	Authority.
		SiO ₂ .	Al ₂ O ₃ .	Fe ₂ O ₃ .	CaO.	MgO			
GLASS-POT CLAYS.									
1	Near St. Louis, Mo.,	63.850	22.310	2.700	.....	.610	.600	10.430	Pittsburgh Plate Glass Co., No. 8.
2	Ardenne, Belgium,	49.04	34.78	1.80	.680	.410	.410	12.00	Die feuerfesten Thone, Bischof, 1876.
3	Stourbridge, England,	64.40	22.22	1.82	.74	.18	1.10	10.30	Die feuerfesten Thone, Bischof, 1876.
4	Stourbridge, England,	53.30	33.89	3.41	.78	.32	1.33	10.50	Die feuerfesten Thone, Bischof, 1876.
5	Schwarzenberg, Germany,	48.97	37.95	3.45	.04	.11	3.00	11.13	Die feuerfesten Thone, Bischof, 1876.
6	Barrois, St. Louis Co.,	55.61	27.36	2.73	.87	.07	.71	11.73	Mo. Geol. Surv., Vol. XI, p. 568.
7	St. Louis, Columbia B. road,	52.98	28.87	2.48	.51	.61	1.01	7.73	Mo. Geol. Surv., Vol. XI, p. 570.
8	St. Louis, Jam. French Fire Clay Co.,	52.52	31.40	2.34	.40	.61	.61	12.62	Min. Res. U. S., 1896.
9	Gross Almerode Hesse,	47.50	34.40	1.20	.50	1.00	.....	15.4	Am. Mfr. and Iron World, Apr. 22, '93.
KAOLINS.									
11	Thomas, Pennsylvania,	43.88	40.96	0.82	tr.	tr.	.....	13.90	Tenth Census, Vol. 2, p. 1078.
12	Blair county, Pennsylvania,	70.38	26.75	1.39	0.55	0.12	.....	10.38	Tenth Census, Vol. 2, p. 1078.
13	Blair county, Pennsylvania,	70.32	26.75	1.39	2.00	.07	.....	7.98	Tenth Census, Vol. 2, p. 1078.
14	Diana, New Jersey,	59.93	26.95	1.24	.....	.14	.08	10.20	Tenth Census, Vol. 2, p. 1078.
15	Barlow, Lake Co. Flor., washed,	49.30	34.50	.65	.....	.14	.....	14.78	A. H. Parslow, Tampa, Fla.
16	Lawrence Co., Ind.,	44.75	38.69	.95	.37	.30	.35	15.17	Ind. Geol. Surv., Vol. XX, p. 105.
17	Glen Allen, Missouri,	72.30	18.94	.68	.....	.39	.42	7.04	Mo. Geol. Surv., Vol. XI, p. 563.
18	Chilton, Carter Co., Missouri, washed,	73.82	18.16	1.32	tr.	.21	.24	6.16	Min. Res. U. S., 1896.
19	Glen Lock, Chester Co., Pa.,	50.96	33.30	.....	.....	2.42	.....	8.95	Min. Res. U. S., 1896.
20	Webster, N. C.,	43.90	40.66	.14	.....	.....	.46	14.74	Geol. Surv., An. Rept. 1885, p. 589.
21	National Kaolin and F. B. Works, Pa.,	67.11	39.22	1.99	.82	.03	.56	7.04	Geol. Surv., An. Rept. 1885, p. 589.
22	National Kaolin and F. B. Works, Pa.,	67.11	39.22	1.99	.82	.04	.77	7.78	Geol. Surv., An. Rept. 1885, p. 588.
23	Easton, Pa.,	46.34	36.32	3.64	.04	.....	.....	13.75	24 Pa. Geol. Surv., An. Rept. 1885, p. 588.
24	Chestnut Hill, Pa.,	67.01	20.10	3.90	.10	.70	2.00	5.90	24 Pa. Geol. Surv., An. Rept. 1885, p. 588.
SLIP CLAYS.									
25	Slip clay, Albany, N. Y.,	56.75	15.47	5.73	5.78	3.32	3.25	8.87	Mo. Geol. Surv., Vol. XI, p. 591.
26	Slip clay, Albany, N. Y.,	62.40	10.42	5.36	9.88	4.23	.37	8.05	Mo. Geol. Surv., Vol. XI, p. 591.
27	Slip clay, Albany, N. Y.,	55.60	14.80	5.85	5.70	2.48	4.40	4.94	Geol. Surv. of Ohio, Vol. VII, p. 105; average of several analyses.



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